SOIL SURVEY OF

Marion County Area, Oregon

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Oregon Agricultural Experiment Station

Issued September 1972

Major fieldwork for this soil survey was done in 1961. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1961. This survey was made cooperatively by the Soil Conservation Service and the Oregon Agricultural Experiment Station. It is part of the technical assistance furnished to the Santiam, Silver Creek, and Mt. Angel Soil and Water Conservation Districts.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of the Marion County Area are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the survey area in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the capability unit and woodland group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text and tables. Interpretations not included in the text or in tables can be developed by grouping the soils according to their suitability or limitations for the desired purpose. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils by reading descriptions of the soils and the discussions of the capability units and woodland groups.

Foresters and others can refer to the subsection "Use of the Soils as Woodland," where the soils of the survey area are grouped according to their suitability for forest trees.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Community planners and others concerned with suburban development can read about soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas in the subsection "Town and Country Planning."

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in the Marion County Area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Area" and in information about the survey area given at the beginning of this publication.

Cover: Landscape showing the Nekia and Jory soils of association 8.

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE OREGON AGRICULTURAL EXPERIMENT STATION

THE MARION COUNTY AREA consists of 544,879 acres in the western two-thirds of Marion County, Oregon (fig. 1). Elevations range from about 100 feet along the Willamette River to about 5,000 feet on the forested foot slopes of the Cascade Mountains. Salem, the State capital, is in this area. Approximately 205,841 acres in the mountainous eastern part of the county, mostly in national forests, is not in the area that was surveyed.

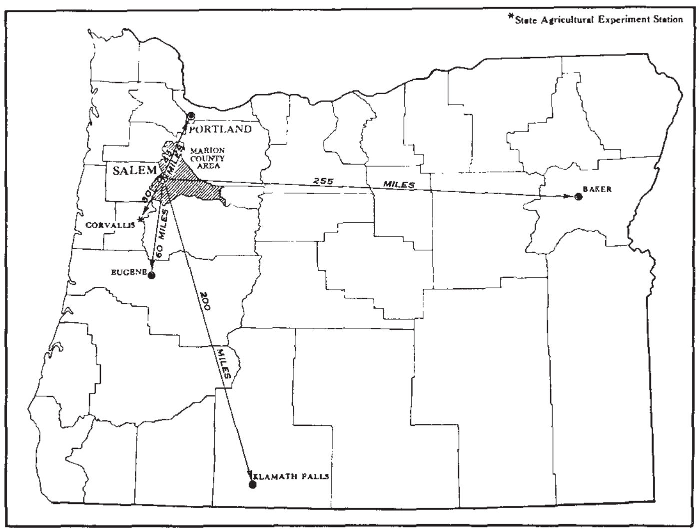

Figure 1.—**Location of the Marion County Area in Oregon.**

The survey area is in the central part of Oregon's Willamette Valley. It has a modified marine climate, which is influenced by the Coast Range to the west and by the Cascade Mountains to the east. Climate in the foot slopes part of the survey area differs considerably from that along the Willamette River, in that the amount of precipitation is greater, the average temperature is lower, and the growing season is shorter.

Farming in what is now the Marion County Area started about 1834. The first farmers derived much of their income from raising livestock and growing small grains. Since World War II, most of the farm income has been derived from the sale of fruits, berries, vegetables, and specialty crops, although wood products are also a major source of farm income. The eastern part of the survey area is used mainly for producing timber.

In mapping the survey area, two intensities of soil mapping were used (fig. 2). In the forested foot slopes of the survey area, soils were examined at moderate to wide intervals and were mapped at medium intensity. In the irrigated and dryfarmed western part of the survey area, the soils were examined at close intervals and were mapped at high intensity, or in considerably more detail than in the forested foot slopes part. Most of the soils mapped at high intensity have a narrow range of slope.

To show which soils were mapped at medium intensity and which at high intensity, the kind of map symbol assigned to the soils mapped at medium intensity was made to differ slightly from the one assigned to the soils mapped at high intensity. The second letter of the map symbol is a capital letter if the mapping unit is one of those in the medium-intensity survey area. It is a small letter if the mapping unit is one of those in the high-intensity survey area. A list of all the soils in the survey area, their map symbol, and the capability unit and the woodland group to which each has been assigned can be found in the "Guide to Mapping Units" at the back of this survey.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the Marion County Area, where they are located, and how they can be used. The soil scientists went into the area knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classi-

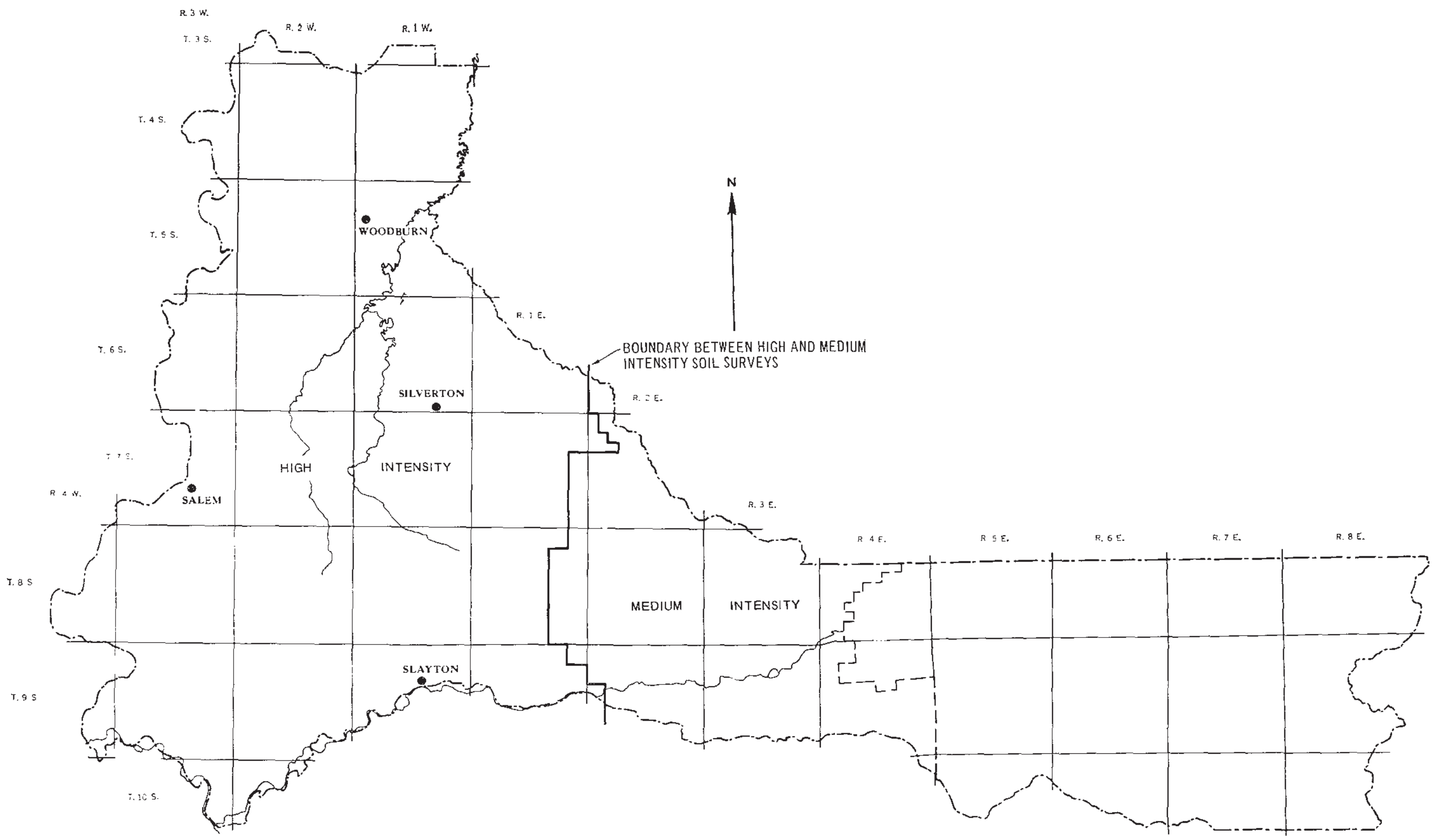

Figure 2.—**Soil survey mapping intensities in the Marion County Area.**

fied and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* (*13*) [1] are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Abiqua and McCully, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slopes, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, McCully clay loam, 2 to 7 percent slopes, is one of several phases within the McCully series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

[1] Italic numbers in parentheses refer to Literature Cited, page 130.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit, called an undifferentiated group, is shown on the soil map of the Marion County Area.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Steiwer and Chehulpum silt loams, 3 to 40 percent slopes, is an example.

In most areas surveyed, there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Stony rock land is a land type in the Marion County Area.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the Marion County Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The 11 soil associations in the Marion County Area are discussed in the following pages. The terms for texture used in the descriptive title for several of the associations apply to the surface layer. For example, in the descriptive title for association 1 the words "silty clay loams to sandy loams" refer to texture of the surface layer.

Somewhat Excessively Drained to Very Poorly Drained, Dominantly Nearly Level Soils on Flood Plains and in Old Lakebeds

These soils are on bottom lands of the Williamette River and its tributaries and on the bottoms of former lakes. They have formed in alluvial and lacustrine materials, and they are mainly nearly level. Drainage ranges from somewhat excessive to very poor, but in nearly half of the acreage, the soils are well drained. Flooding is a hazard in many places. In some areas the water table is high during some parts of the year.

Three associations are in this group. Most of the soils in these associations are farmed, and many different crops are grown on some of them.

1. Cloquato-Newberg-Chehalis association

Well-drained and somewhat excessively drained silty clay loams to sandy loams; on flood plains

This association consists of nearly level and gently undulating soils that formed in mixed alluvium on bottom lands of the Willamette River and its tributaries. The areas are traversed by numerous meandering sloughs and overflow channels. Elevations range from 100 to 650 feet. The annual precipitation is 40 to 45 inches, the annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly alder, ash, cottonwood, oak, maple, and Douglas-fir; grasses; and wild blackberry, rose, and other shrubs.

This association occupies about 9 percent of the survey area. Cloquato, Newberg, and Chehalis soils are dominant (fig. 3). Cloquato soils make up about 45 percent of the association, Newberg soils about 25 percent, and Chehalis soils about 13 percent. Camas soils make up an additional 12 percent, and the rest of the association consists of small areas of Alluvial land and of McBee and Wapato soils.

All of the soils are deep. The Cloquato, Newberg, and Camas soils are subject to frequent overflow. The Chehalis soils are rarely flooded, because they occupy the higher parts of the flood plains.

The Cloquato and Chehalis soils are well drained. The Cloquato soils have a surface layer and a subsoil of dark-brown silt loam. The Newberg soils are somewhat excessively drained. They have a surface layer of very dark grayish-brown fine sandy loam or silt loam, and they are dark yellowish-brown sandy loam beneath the surface layer. The Chehalis soils have a surface layer, a subsoil, and a substratum of dark-brown silty clay loam.

Soils of this association are used mainly for small grains, pasture, hay, orchards, and grass grown for seed, but vegetables and berries are grown when some areas are irrigated. A protective cover of plants is needed on the Cloquato, Newberg, and Camas soils in winter and early in spring, when most flooding occurs. Farm enterprises are varied, but they consist primarily of growing fruit trees, vegetables, and specialty crops.

Wildlife is abundant on these soils. The sloughs are inhabited by ducks, geese, and fish, and enough browse and other plants are available to provide food and cover for quail, pheasant, rabbit, and deer.

This association is well suited to use for development of recreational facilities. It is easily accessible, is near populated areas, and has readily available water for recreation, domestic use, and irrigation.

Where the soils are protected from overflow, their engineering properties make them moderately well suited to development as sites for roads, trails, and buildings. The Camas soils are an excellent source of gravel.

2. Wapato-Bashaw-McBee association

Very poorly drained to moderately well drained silty clay loams to clays; on flood plains

This association consists of nearly level soils in low, backwater areas of flood plains that are subject to frequent

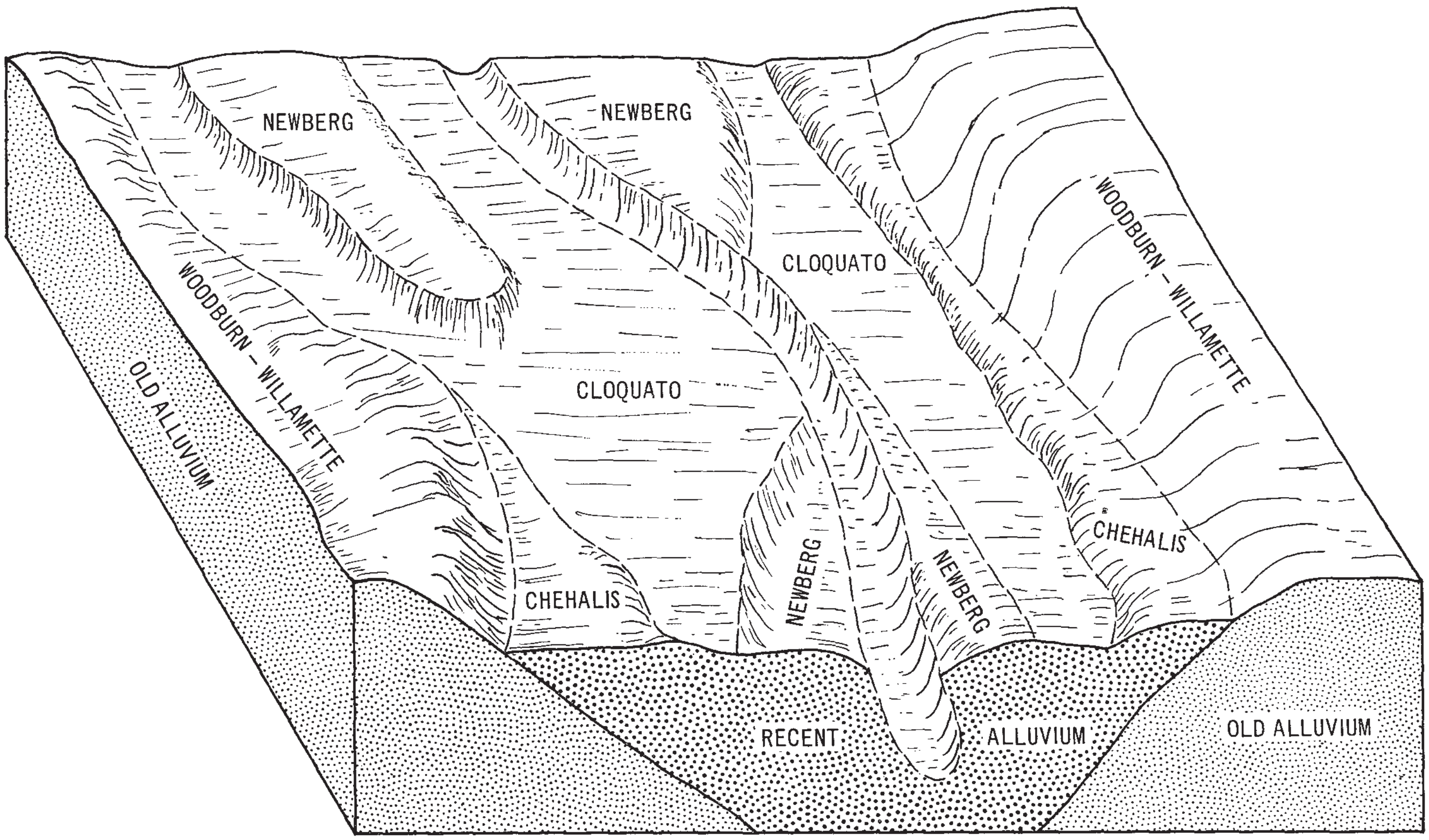

Figure 3.—Pattern of Cloquato, Newberg, and Chehalis soils of association 1 and adjacent older soils on higher terraces.

overflow. It is traversed by sloughs and overflow channels. The soils have formed in moderately fine textured and fine textured alluvium, and they occur at elevations of 100 to 650 feet. The annual precipitation ranges from 40 to 45 inches, the annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly grasses, blackberries, sedges, rushes, willows, ash trees, oaks, maples, and alders.

This association occupies about 4 percent of the survey area. Wapato, Bashaw, and McBee soils are dominant. Wapato soils make up about 55 percent of the association, Bashaw soils about 24 percent, and McBee soils about 18 percent. The rest of the association consists of minor areas of Chehalis, Cloquato, and Labish soils.

The Wapato soils are poorly drained. They occupy low areas that have impeded outlets. In winter and early in spring, the Wapato soils are inundated by overflow from streams and by runoff from adjacent terraces. These soils are mottled throughout, and they have a very dark brown silty clay loam surface layer, a very dark grayish-brown silty clay loam subsoil, and a dark-brown silty clay loam substratum.

The Bashaw soils commonly occur in small depressions within areas of Wapato soils. They are poorly drained and very poorly drained, and they are subject to overflow. The Bashaw soils have a surface layer of mottled black clay that is underlain by a substratum of mottled very dark gray and dark grayish-brown clay.

The McBee soils are moderately well drained. They have a surface layer of very dark brown silty clay loam; a subsoil of dark-brown, faintly mottled silty clay loam, and a substratum of dark-gray clay loam.

Soils of this association are used mainly for pasture, hay, and small grains, but small tracts are used for vegetables and orchards. The Bashaw soils are better suited to use for pasture and to grass grown for seed than to other crops. Drained areas of the Wapato and McBee soils are suited to vegetables, berries, and many other crops if they are irrigated. The farms are large. Dairying and the raising of livestock are main sources of farm income, but some income is derived from the sale of vegetables and fruit.

Where the soils have not been drained and farmed, species of wildlife that prefer wetlands are plentiful. Waterfowl and fish inhabit the sloughs and streams. In most places quail and pheasant can find adequate cover.

This association is poorly suited to use for development of recreational facilities, even though it is near populated areas and is readily accessible. The soils have engineering properties that make them poorly suited to development as sites for roads, trails, and buildings. Flooding is a hazard in most years.

3. Labish-Semiahmoo association

Poorly drained silty clay loams and silty clays, on old lakebeds; and organic soils, on old lakebeds

This association consists of nearly level soils on the bottoms of former lakes, mainly on the Labish Bottom. Some of the soils have formed in mixed mineral and organic material, and others have formed in organic material. Elevations range from about 130 to 175 feet. The annual precipitation is 40 to 45 inches, the annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days.

This association occupies less than 1 percent of the survey area. About half of it consists of poorly drained Labish soils, and the other half, of poorly drained Semiahmoo soils. The Labish soils have a surface layer of black silty clay loam and silty clay that is high in content of organic matter and is underlain by very dark gray clay. The Semiahmoo soils have a surface layer of black muck that is underlain by very dark brown peaty muck and peat.

The growing of specialty crops and the production of onions (fig. 4) are the main farm enterprises in this association. Small grains, pole beans, sweet corn, berries, and hay are grown on small acreages, and a small acreage is in pasture. Where these soils are drained, they are well suited to crops and they have high value. Areas that are not drained and that are not protected are subject to flooding. In the past, onion growers risked serious losses by planting their crop in areas subject to flooding. Dikes and a pumping unit are now used to overcome this hazard.

Soils of this association are intensively managed for crops. Therefore, little food or cover is available for wildlife. The high value of the soils makes it unlikely that greater encouragement will be given to wildlife in the future.

This association is poorly suited to use for development of recreational facilities. The soils also have engineering properties that make them poorly suited to development as sites for roads, trails, and buildings.

Poorly Drained to Excessively Drained Soils on Alluvial Terraces

These soils are on alluvial terraces. They occupy a fairly broad belt that lies between areas of alluvial soils on bottom lands and areas of soils on low foothills. Silty soils occupy a large acreage, and clayey and gravelly soils occupy small tracts. Elevations range from 100 to 650 feet. The annual precipitation is 40 to 45 inches.

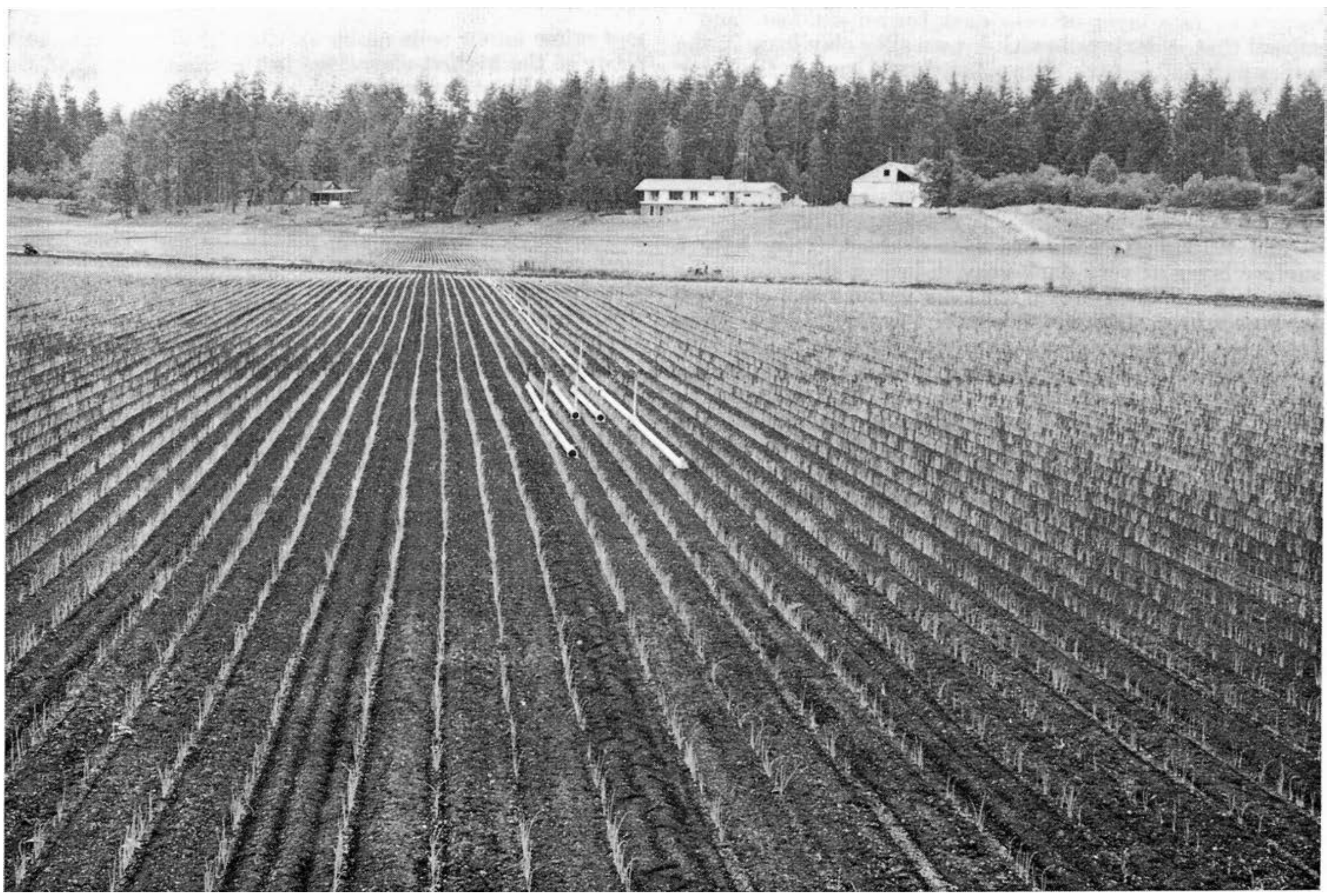

***Figure 4.*—Onions growing on Semiahmoo muck near Lake Labish.**

Three associations are in this group. More than half of the acreage consists of soils that are influenced by a seasonal high water table. Many different crops are grown on most of the soils.

4. Woodburn-Amity-Willamette association

Dominantly level to rolling, well-drained to somewhat poorly drained silt loams over silty clay loam

This association consists of soils that occupy areas of Willamette silts above the bottom lands of the North Santiam, Santiam, and Willamette Rivers. These soils are dominantly nearly level to rolling, and they have formed in silty alluvium of mixed mineralogy. Elevations range from 150 to 350 feet. The annual precipitation is 40 to 45 inches, the annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly grasses, shrubs, hardwoods, and Douglas-fir.

This association occupies about 20 percent of the survey area. Woodburn, Amity, and Willamette soils are dominant. Woodburn soils make up about 60 percent of the association, Amity soils about 30 percent, and Willamette soils about 8 percent. The rest of the association consists of small areas of Concord, Dayton, Wapato, and Bashaw soils. All of the soils are deep.

The Woodburn soils are moderately well drained. They have a surface layer of very dark brown silt loam and a subsoil that is dark yellowish-brown silty clay loam in the upper part and is dark-brown, brittle silt loam in the lower part. Their substratum is dark-brown silt loam.

The Amity soils are somewhat poorly drained. They have a surface layer of very dark grayish-brown silt loam; a subsurface layer of dark-gray silt loam; a subsoil of mottled grayish-brown silty clay loam; and a substratum of olive-brown silt loam.

The Willamette soils are well drained. They have a surface layer of very dark grayish-brown silt loam and a subsoil that is dark-brown silt loam in the upper part and is dark-brown silty clay loam in the lower part. Their substratum is dark yellowish-brown silt loam.

The major soils of this association are used mainly for small grains, pasture, hay, orchards, and grass grown for seed. Use of these soils is gradually changing, however, and some berries, vegetables, and specialty crops are grown. Obtaining water for irrigation is probably the most limiting factor to use of the soils for growing vegetables and specialty crops. Nevertheless, water can generally be obtained from wells without lowering the water table. In some areas ponds and dams have been constructed to provide places for storing irrigation water. As a result, enough water is available for irrigation in those places so that the damaging effects of dry weather in summer are overcome. In most places the soils are not well suited to use for constructing either the reservoir area or the embankment of a pond. Therefore, choosing the site for a pond requires care.

All of the soils, except the Willamette, have a perched water table in winter and early in spring. For these wet soils, drainage is needed. Some crops can be grown on undrained areas of Amity soils, but drainage is needed for best returns. Other crops will not grow unless drainage is provided. Natural drainageways throughout the association provide adequate outlets for artificial drainage, and response to artificial drainage is good.

Abundant food and cover are available for game birds. As a result, many quail and pheasant inhabit the area. The association is readily accessible and is close to populated areas, but it is not well suited to use for development of recreational facilities. The soils have engineering properties that make them only moderately well suited to development as sites for ponds, dikes, roads, and buildings.

5. Concord-Dayton-Amity association

Nearly level, poorly drained and somewhat poorly drained silt loams over silty clay, clay, and silty clay loam

This association consists of soils in nearly level areas, in depressions, and in shallow, imperfectly developed drainageways. It is mainly on divides between the drainage areas of the Little Pudding and Pudding Rivers and Champoeg and Mission Creeks. The soils have formed in silty and clayey alluvium, and they occur at elevations of 125 to 350 feet. The annual precipitation is 40 to 45 inches, the annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly grasses, sedges, rushes, shrubs, and hardwoods.

This association occupies about 6 percent of the survey area. Concord, Dayton, and Amity soils are dominant. Concord soils make up about 40 percent of the association, Dayton soils about 30 percent, and Amity soils about 20 percent. Holcomb soils make up an additional 5 percent, and other minor soils make up the rest. The Amity soils occur at the highest elevations in the association, and the Dayton soils, at the lowest.

The Concord soils are poorly drained. They have a surface layer of very dark grayish-brown silt loam; a subsurface layer of mottled, dark-gray silt loam; a subsoil of mottled, grayish-brown silty clay; and a substratum of dark grayish-brown silt loam.

The Dayton soils are also poorly drained. They have a surface layer and a subsurface layer similar to those of the Concord soils, but their subsoil is dark-gray and grayish-brown clay, and their substratum is grayish-brown silty clay loam.

The Amity soils are somewhat poorly drained. They have a surface layer of very dark grayish-brown silt loam; a subsurface layer of dark-gray silt loam; a subsoil of mottled, grayish-brown silty clay loam; and a substratum of olive-brown silt loam.

The major soils of this association are used mainly for small grains, pasture, hay, and grass grown for seed. The soils contain a perched water table, and water ponds on the surface during wet periods in winter and spring. Drainage is needed if crops are to grow well (fig. 5). Both drainage and irrigation are needed for many crops, and they would benefit all crops that are presently grown.

Obtaining enough water for irrigation and other purposes is difficult in summer, but supplemental water has been provided by constructing a few farm ponds. These soils are poorly suited to use for ponds or dams, however, and natural sites for dams are few. Therefore, if a pond is to be constructed, care must be used in choosing a site.

Abundant food and cover are available for game birds, and as a result, quail and pheasant are plentiful. The association is readily accessible and is near populated areas, but it is not well suited to use for development of recreational facilities. The soils have engineering properties

Figure 5.—**Field corn growing on Dayton and Holcomb silt loams. The corn on the Dayton soil in the foreground is stunted. That on the Holcomb soil in the background is growing well.**

that make them poorly suited to use as sites for buildings and roads.

6. Clackamas-Sifton-Salem association

Nearly level, somewhat poorly drained to excessively drained gravelly loams and gravelly silt loams over gravelly clay loam and gravelly sand

This association consists of nearly level soils on low terraces in the Stayton Basin and along Mill Creek between Turner and Salem. It is traversed by a network of shallow drainageways. The soils have formed in gravelly alluvium, and they occur at elevations of 100 to 650 feet. The annual precipitation is 40 to 45 inches, the annual temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, hazel, brackenfern, shrubs, and grasses.

This association occupies about 5 percent of the survey area. Clackamas, Sifton, and Salem soils are dominant. Clackamas soils make up about 35 percent of the association, Sifton soils about 25 percent, and Salem soils about 21 percent. Courtney soils make up nearly another 19 percent, and minor areas of Abiqua and Willamette soils make up the rest.

Sifton soils occupy the highest parts of the association. They occupy scattered islands of 5 to 100 acres throughout the association, within larger areas of Clackamas soils. The Salem soils occur along terraces that are adjacent to the flood plains of the North Santiam and Santiam Rivers, along Mill Creek, and along intermittent drainageways. The Courtney soils are in shallow drainageways.

The Clackamas soils are somewhat poorly drained. They have a surface layer of very dark grayish-brown gravelly loam; a subsoil of mottled, very dark gray gravelly clay loam; and a substratum of mottled, dark-brown very gravelly clay loam.

The Sifton soils are excessively drained. They have a surface layer of black gravelly loam; a subsoil of dark-brown gravelly loam; and a substratum of dark-brown very gravelly and cobbly sand.

The Salem soils are well drained. They have a surface layer of very dark brown gravelly silt loam; a subsoil of dark-brown very gravelly clay loam; and a substratum of grayish-brown gravelly sand.

Farms in this association are generally small, but they are increasing in size. Ownership of the farms changes frequently. Some areas are used as woodland. In areas that are farmed, the soils are used mainly for small grains, pasture, hay, orchards, beans, other vegetables, sweet corn, berries, and grass grown for seed. Wetness limits the choice of crops that can be grown on the Clackamas soils. The Clackamas soils are not suited to fruit trees and to other deep-rooted crops, but where drained, they are used for most of the crops commonly grown in the survey area. The

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Sifton soils have lower available water capacity, and therefore, they require more frequent irrigation than the Salem and Clackamas soils.

Game birds can find abundant food and cover, and adequate water is readily available in irrigation ditches and drainage ditches. As a result, quail and pheasant are plentiful. Much of the acreage is being cleared, however, because vegetables are grown extensively and because this association is near processing plants. Clearing the areas for crops destroys the natural cover and supplies of food that were formerly available for wildlife. If odd areas that can provide food and cover are not soon developed, the population of quail and pheasant will rapidly decline. Some development of areas suitable for waterfowl is feasible, but the need for drainage ditches generally makes this difficult.

This association is moderately well suited to use for development of recreational facilities. Where adequate outlets are provided, the Clackamas soils are easily drained. The Salem and Sifton soils are already suitable as sites for camping and for roads, and for the most part, construction of roads and trails is fairly easy. This association is in an irrigation district, and water for recreation and domestic use is available.

Well Drained and Moderately Well Drained Soils of the Low Foothills

These soils are on low foothills, generally between alluvial terraces and the foot slopes of the Cascade Mountains. They are known as red hill soils. Most of these soils have clayey horizons below the surface layer. They are mainly underlain by basalt, but the soils in rather large areas are underlain by sedimentary bedrock. Drainage is moderately good or good. Elevations range from 250 to 1,000 feet, and the annual precipitation ranges from 40 to 60 inches.

Two associations are in this group. The soils of these associations are used mainly as woodland or are farmed. In the wooded areas, Douglas-fir is the dominant species, but oak grows on some of the soils.

7. *Steiwer-Chehulpum-Hazelair association*

Well drained and moderately well drained silt loams over silt loam to clay; 2 to 40 percent slopes

This association is on low foothills that border the Salem Hills on the south and west. The soils have formed in sedimentary material and in material, possibly alluvium, that has been deposited over the sedimentary material. Thickness of the surface deposit varies, but this material is thickest on the floor of the valley, and it is thinner towards the red foothills. Elevations range from 250 to 650 feet, annual precipitation ranges from 40 to 60 inches, and the annual air temperature is 52° to 54° F. Length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly oak, rose, poison-oak, and grasses.

This association occupies about 1 percent of the survey area. Steiwer, Chehulpum, and Hazelair soils are dominant (fig. 6), but the association also contains minor areas of Chehalem, Silverton, and Nekia soils. An undifferen-

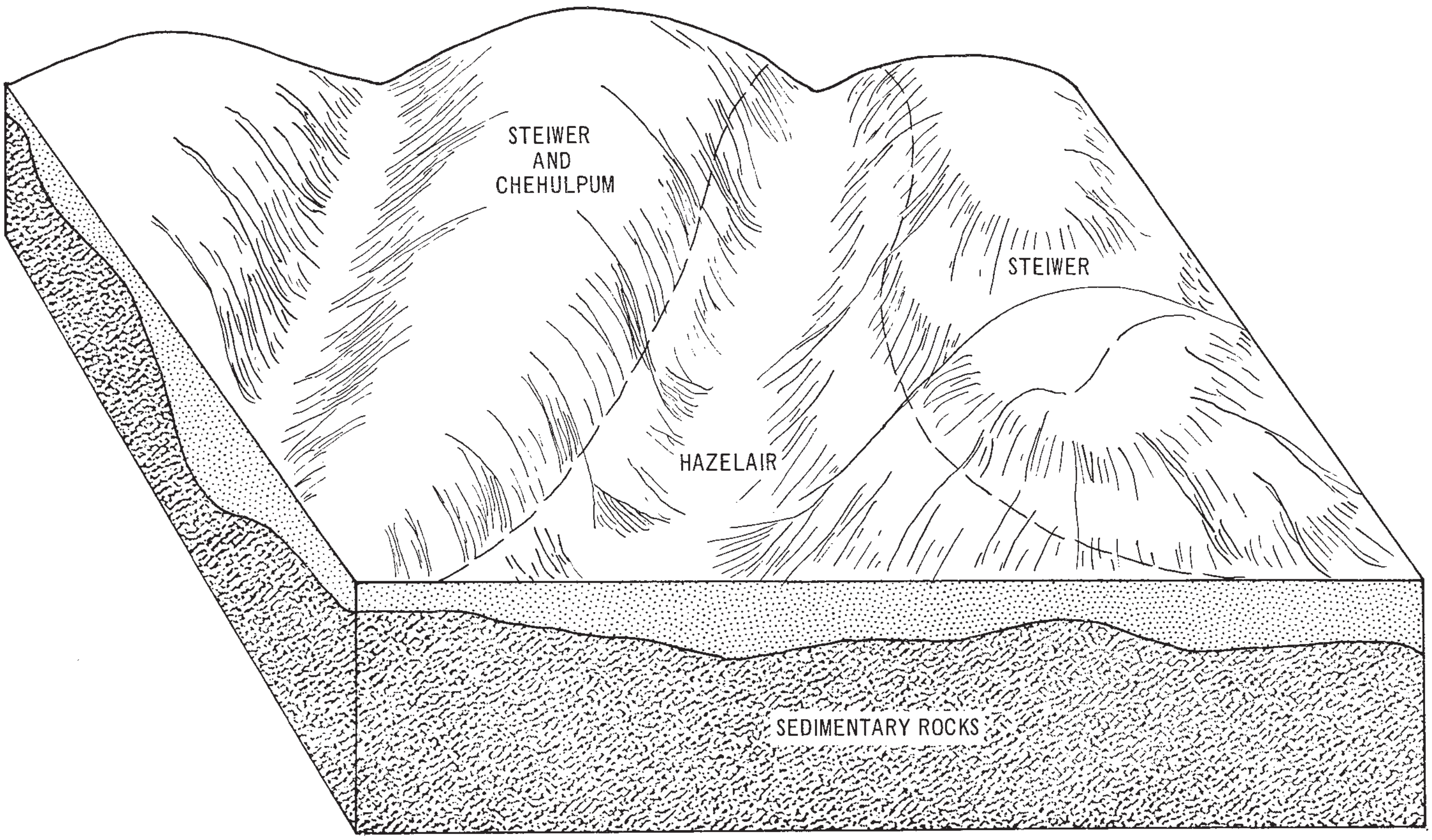

Figure 6.—**Pattern of Steiwer, Chehulpum, and Hazelair soils in association 7.**

tiated mapping unit of Steiwer and Chehulpum soils makes up about 45 percent of the association, Hazelair soils make up about 30 percent, and Steiwer soils mapped alone make up about 20 percent. Minor soils make up the rest.

The Steiwer soils are well drained. They have a surface layer of very dark brown silt loam; a subsurface layer of dark-brown silt loam; and a subsoil of dark yellowish-brown silty clay loam. Sedimentary bedrock is at a depth of 20 to 40 inches.

The Chehulpum soils, also well drained, have a surface layer of very dark brown silt loam. The surface layer is underlain by sandstone at a depth of 10 to 20 inches.

The Hazelair soils have a surface layer of very dark brown silt loam; a subsoil of very dark grayish-brown silty clay loam; and a substratum of mottled, dark grayish-brown clay that is underlain by sandstone. Depth to the clayey substratum is 12 to 24 inches.

Soils of this association are used mainly as woodland and for small grains, pasture, hay, and grass grown for seed. They are the least suitable for farming of any soils in the survey area.

Quail, pheasant, and other kinds of small game birds and game animals are plentiful. Wildlife can find abundant food and cover, and they can generally obtain adequate water from streams and from irrigation ditches in adjacent associations. The numbers of small game animals and game birds could be increased by building low dams for impounding water and by improving the habitat for waterfowl. At present, this association lacks suitable habitat for waterfowl.

This association offers some possibilities for recreation. It contains scenic areas and favorable sites for dams, and the soils are too rolling to be well suited to intensive use for cultivated crops. The soils are fairly suitable as sites for buildings, and they also are fairly suitable as sites for roads and trails. Lack of adequate water for irrigation is the most limiting factor to use of these soils for some purposes.

8. *Nekia-Jory association*

Well-drained silty clay loams over clay; 2 to 50 percent slopes

This association consists of soils on uplands of the Salem and Waldo Hills. The soils in the vicinity of the Salem Hills, south of Salem, are moderately steep and have been deeply dissected by streams. Those on the Waldo Hills to the east are mostly gently sloping and moderately sloping, but they are steep where breaks occur in areas dissected by the major streams. One large area of the association in the Waldo Hills extends northward from the North Santiam River to Butte Creek. It extends eastward to the foot slopes of the Cascade Mountains and parallels the foot slopes of those mountains. Between Turner and Salem, this association is dissected by areas of gravelly soils on terraces along Mill Creek.

Soils of this association have formed in colluvium from basalt and tuffs, and they are among the oldest in the survey area. Elevations range from 300 to 1,000 feet. The annual precipitation ranges from 40 to 60 inches, the annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, but it includes scattered oaks and an understory of poison-oak, rose, and brackenfern.

This association occupies about 23 percent of the survey area. Nekia and Jory soils are dominant; Nekia soils make up about 65 percent of the association, and Jory soils about 20 percent. Minor areas of Stony rock land and of Salkum, Abiqua, Waldo, Stayton, Silverton, Santiam, and Witzel soils make up the rest.

The Nekia and Jory soils are well drained. The Nekia soils have a surface layer of dark reddish-brown silty clay loam and a subsoil of dark reddish-brown clay. They are underlain by basalt bedrock at a depth of 20 to 40 inches. The Jory soils also have a surface layer of dark reddish-brown silty clay loam. The upper part of their subsoil is dark reddish-brown silty clay, and the lower part of their subsoil is dark reddish-brown clay. The Jory soils are underlain by basalt bedrock at a depth of more than 5 feet.

Soils of this association are used mainly as woodland and for small grains, orchards, pasture, hay, and grass grown for seed. Some areas that are irrigated are used mostly for specialty crops and vegetables. Moisture is adequate for growing most field crops, but supplemental irrigation is needed for best returns if vegetables and specialty crops are to be grown commercially. Many areas are suitable for small ponds that could be used for storing irrigation water, and a few sites are suitable for large dams. If cultivated, the steeper soils are subject to erosion, but erosion is easily controlled.

Management of fields used for growing grass for seed has prevented game animals and game birds from becoming well established. Game animals and game birds are few, except along the breaks, where the soils are steeper than in other areas and are not cultivated. A deer is occasionally seen in uncleared areas of breaks and along streams, and the larger streams contain fish. A few quail and pheasant have come into the area, but they are usually forced to go to the lower adjoining associations or to the rough breaks late in summer, when stubble of the grass is burned. If management were changed, the association would provide adequate food and cover for quail and pheasant, but water would still be lacking in summer when the weather is especially dry. The association has many features that could be improved to make the habitat more suitable for existing kinds of wildlife and for waterfowl. The areas could also be improved for fishing.

Many features make this association suitable for the development of recreational facilities. If large dams were constructed, water could be impounded for use for boating and fishing, and also as habitat for waterfowl. The soils are suitable as sites for buildings, and they are fairly suitable as sites for roads and trails. In most places ground water is available for domestic use. Most of the areas have sites suitable for storing a limited supply of water for irrigation.

Moderately Well Drained and Well Drained Soils on the Foot Slopes of the Cascade Mountains

These soils are mostly steep or very steep. They are on foot slopes of the Cascade Mountains in the rugged eastern part of the survey area. Some of the soils are on ridges, and others occupy long slopes that are dissected by numerous streams. The soils occur at elevations of 800 to 5,000 feet. Those at the lower elevations are clayey, and those at the higher elevations are loamy. The annual precipitation ranges from 55 to 90 inches.

Three associations are in this group. They are mostly wooded, but some of the areas at the lower elevations are farmed. Douglas-fir and hemlock are the principal species of trees growing at the lower elevations. Noble fir and silver fir are the principal species of trees growing at the higher elevations.

9. McCully association

Well-drained clay loams over clay; 2 to 70 percent slopes

Part of this association consists of gently sloping to moderately steep soils on broad ridges. The rest consists of steep or very steep soils on breaks, where streams have deeply dissected the area. The soils have formed in till and colluvium, and they occur at elevations of 800 to 2,000 feet. The annual precipitation is 55 to 75 inches, the annual air temperature is 48° to 51° F., and the length of the frost-free season is 165 to 190 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, hemlock, vine maple, maple, and brackenfern, as well as salal, snowberry, and other shrubs.

This association occupies about 15 percent of the survey area. McCully soils make up about 90 percent of the acreage, Hullt soils make up about 5 percent, Cumley soils about 3 percent, and other minor soils about 2 percent.

The McCully soils are well drained. They have a surface layer of dark reddish-brown clay loam and a subsoil of dark reddish-brown clay. A substratum of weathered, basic igneous agglomerate is at some depth between 40 inches and 12 feet.

Soils of this association are used mainly as woodland and for small grains, pasture, hay, and grass grown for seed, but a few areas are used for strawberries and orchards. About half of the association is wooded or has been cut over. Moisture is adequate for growing most field crops, but supplemental water is needed for vegetables and berries. Few suitable sites are available for either large or small dams.

Wildlife is abundant. Quail, pheasant, and grouse are numerous, and deer are so plentiful that many cultivated fields are fenced to keep the deer out. A bear or a cougar is occasionally seen. The streams contain trout, but they are overfished. Additional areas could be made available for fish by constructing dams where sites are available. During dry summers additional water is needed for wild game birds.

Except for the steep or very stony areas, all of the soils are suitable for cultivation. As areas are cleared and cultivated, however, they become less suitable for wildlife. Because of the steep breaks along streams, this association should still remain well suited to wildlife, even though some areas are cultivated.

This association offers good possibilities for development of recreational facilities. It contains scenic areas, is not densely populated, and is adjacent to timbered uplands that are not suitable for cultivation. Fishing and hunting are available, and additional facilities for boating and fishing could be provided. The soils are suitable as sites for buildings and for camping, and they are fairly suitable as sites for roads and trails. Water for domestic use is available from wells.

10. Kinney-Horeb association

Well drained and moderately well drained dominantly cobbly loams and loams over cobbly clay loam or cobbly loam; 0 to 70 percent slopes

Some soils of this association are on broad, irregular ridges that are dissected by streams. Others occupy long slopes that end in abrupt, short breaks leading to the basin area adjacent to streams. The soils are gently sloping to very steep, and they have formed in till and colluvium. Elevations range from 1,000 to 3,500 feet. The annual precipitation is 60 to 90 inches, the annual air temperature is 46° to 50° F., and the length of the frost-free season is 120 to 165 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, hemlock, alder, salal, vine maple, brackenfern, swordfern, and rhododendron.

This association occupies about 10 percent of the survey area. Kinney and Horeb soils are dominant. Kinney soils make up about 74 percent of the association; Horeb soils about 24 percent; and small areas of Minniece, Henline, and McCully soils about 2 percent.

The Kinney soils are well drained. They have a surface layer of very dark brown cobbly loam and a subsoil of dark yellowish-brown cobbly clay loam. The upper part of their substratum is dark yellowish-brown cobbly loam, and the lower part is variegated olive-brown to dark-red, weathered, basic igneous agglomerate.

The Horeb soils are moderately well drained and well drained. They have a surface layer of very dark brown loam, a subsoil of dark yellowish-brown gravelly loam, and a substratum of mottled, dark grayish-brown cobbly loam.

Nearly all of this association is used for growing Douglas-fir. Most of the association is in large tracts held by private timber companies and logging companies, but a few, small, scattered tracts are federally owned or are owned by the State or the county. A few farms, used mainly for the raising of livestock and for growing timber, are located along the North Santiam River.

Soils of this association are poorly suited to farming. The Kinney soils are too cobbly for cultivation, and the growing season is shorter than in association 8. In addition, the nights are cool enough that crops do not mature until after rains have started in fall. Controlling erosion has not been difficult under past land use.

Deer are abundant in this association, and bears are common. Grouse and quail are plentiful, and there are a few rabbits. Beaver have built dams along most streams, and fishing is good in the streams. Much of the moisture is in the form of snow that falls late in fall and in winter. The snow does not accumulate to an appreciable depth, and the cover of snow is patchy. Therefore, wildlife can find adequate food all year. Deer come down from higher areas in winter, and they concentrate in this association. They cause some damage to timber and young trees, which they use for browse.

This association offers little opportunity for recreation. It is near populated areas and is accessible, but because of the risk of fire, most of the area is closed to the public in summer. Furthermore, although winters are rather mild, low clouds and haze obscure the beauty of scenic areas, and the snow cover is generally inadequate for winter sports. Few sites are suitable for dams of any size.

11. *Whetstone-Henline association*

Well-drained stony loams and very stony sandy loams; 3 to 80 percent slopes

This association occupies the middle slopes of the Cascade Mountains. It extends in a broad strip, probably to the foot slopes of Mt. Jefferson, which lies east of the survey area. The association is characterized by sharp, knifelike ridges having side slopes that plunge abruptly to basins or bottoms along streams. The soils have formed in colluvium and till. Elevations range from 3,000 to 5,000 feet. The annual precipitation ranges from 70 to 90 inches, the annual air temperature is 41° to 45° F., and the length of the frost-free season is 90 to 110 days.

This association occupies about 6 percent of the survey area. Whetstone and Henline soils are dominant. Whetstone soils make up about 65 percent of the association, and Henline soils about 30 percent. Minor areas of Horeb and Kinney soils make up about 5 percent.

The Whetstone soils are well drained. They have a surface layer of dark-gray stony sandy loam; a subsoil that is dark reddish-brown stony loam in the upper part and dark-brown stony loam in the lower part; and a substratum of dark yellowish-brown stony loam. Bedrock is at some depth between 20 and 40 inches.

The Henline soils, also well drained, have a surface layer of very dark brown very stony sandy loam and a subsoil of dark-brown very stony sandy loam. Their subsoil is underlain by basalt bedrock at a depth of 20 to 40 inches.

All of this association is in large timbered tracts that are privately owned, federally owned, or State owned. The association is covered with snow in winter and spring, and the cool climate and large amount of moisture make use and management of the soils difficult. None of the acreage is cultivated, for the soils are too stony and steep for cultivation. Under proper management the soils are moderately well suited to Douglas-fir, noble fir, silver fir, and hemlock.

From May to November, deer, bear, grouse, and other kinds of wildlife are plentiful, and there are a few rabbits and beaver. As the depth of snow increases, however, deer are forced to descend to lower areas for food and cover. Fishing is fair.

This association offers only limited opportunities for recreation. The area is closed to the public during the time when fires are most prevalent. In winter, it is mostly inaccessible, although a few logging roads and fire roads have been constructed along the larger streams. The snow cover is adequate for winter sports, but the terrain is unsuitable in most places.

Use and Management of the Soils

This section describes use and management of the soils of the Marion County Area for crops and pasture. It also discusses woodland and engineering uses of the soils and names soil features that affect uses of the soils for town and country planning.

Management for Crops and Pasture

Among the crops commonly grown in the survey area are pole beans, bush beans, sweet corn, blackberries, strawberries, cherries, English walnuts, filberts, small grains, and forage crops. In addition, large acreages are used for pasture and for grass grown for seed. In the following pages, practices suitable for soils used for these main crops are described. First, the system of capability classification is explained and management suitable for the soils of each capability unit is discussed. Then, predicted average acre yields of some of the principal crops are given for a high level of management. Finally, specific management practices are described for each of the crops for which predicted average acre yields are given.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed 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, 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, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, 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 largely to pasture, range, woodland, or wildlife. (No soils of this class are in the survey area.)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

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 too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations.

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similiar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIe-3. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

Management by capability units

In the following pages the capability units in the Marion County Area are described and suggestions for use and management of the soils of each unit are given. The names of soil series represented are mentioned in the description of each capability unit, but this does not mean that all the soils of a given series are in the unit. To find the names of all the soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1

This capability unit consists of well-drained Abiqua, Chehalis, and Willamette soils that have a surface layer of silty clay loam or silt loam and a subsoil of silty clay or silty clay loam. These soils have formed in alluvium on bottom lands and terraces. Their slopes range from 0 to 3 percent. The annual precipitation is 40 to 60 inches, and the length of the frost-free season is 190 to 210 days.

Permeability is moderate or moderately slow, and the available water capacity is high or very high. Fertility is moderate to high. The effective depth to which roots can penetrate is 5 feet or more. Runoff is slow, and erosion is only a slight hazard if rains are of normal intensity. Flooding is not a hazard on these soils.

Soils of this unit are suited to all the commonly grown crops that require good drainage. They are used mainly for wheat, barley, oats, field corn, orchards, grasses, and forage crops. When irrigated, these soils are commonly used for sweet corn, strawberries, beans, and pasture.

All crop residue should be returned to the soils. A cropping system in which grasses and legumes are grown at least 25 percent of the time helps to maintain favorable soil fertility and workability.

Small grains and grasses respond to nitrogen fertilizer, row crops respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on these soils also respond to lime.

Water can be applied by means of furrow, border, or sprinkler irrigation, but sprinkler irrigation is most commonly used. Smoothing the soils for irrigation or for surface drainage is easier than for some soils, and it does not permanently damage the soils. Water from streams or shallow wells is readily available in most places for irrigating the Abiqua and Chehalis soils. Water from wells that are 80 feet or more deep is used for irrigating the Willamette soil. These deep wells generally provide enough water for the commonly grown crops.

CAPABILITY UNIT IIe-1

This capability unit consists of moderately well drained and well drained McAlpin, Salkum, Santiam, and Woodburn soils that have a surface layer of silty clay loam or silt loam and a subsoil of silty clay, silt loam, or silty clay loam. These soils have formed in alluvium on fans, bottom lands, and terraces. They have slopes that mainly are between 0 and 6 percent but that are as steep as 12 percent in the Woodburn soil. The annual precipitation is 40 to 60 inches, and the length of the frost-free season is 190 to 210 days.

Permeability is moderately slow or slow, and the available water capacity is high or very high. Fertility is moderate to high. The effective depth to which roots can penetrate ranges from about 2 feet to more than 5 feet. Runoff is slow to medium, and erosion is a slight to moderate hazard.

Soils of this unit are suited to row crops, small grains, forage crops, vegetables, and many specialty crops. In some areas somewhat restricted drainage restricts the choice of crops. In places long-lived, deep-rooted deciduous fruit trees and nut trees and strawberries, raspberries, and alfalfa do not grow well unless the soils are drained.

Erosion is easily controlled by farming across the slope, establishing grassed waterways, practicing rough tillage, and protecting the soils with a winter cover crop or stubble mulch. Returning all crop residue to the soils and using a cropping system that includes grasses and legumes grown at least 50 percent of the time will also help to reduce runoff and erosion, and these practices help to maintain favorable soil fertility and workability.

Small grains and grasses respond to nitrogen fertilizer, row crops commonly respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on these soils also respond to lime.

Water can be applied by means of sprinkler or furrow irrigation, but irrigation increases the hazard of erosion. Therefore, water should be carefully applied, preferably by using sprinkler irrigation or the contour-furrow method, at rates low enough to prevent runoff. In places water for irrigation is taken from reservoirs or streams, but water for irrigating the McAlpin and Woodburn soils is generally taken from wells. In most places adequate water is not available from wells for irrigating the Salkum and Santiam soils. Water stored in ponds and reservoirs is used for irrigating those soils.

Grid drainage is needed for maximum use of these soils and for best returns. Seepage from higher areas can be controlled by installing interceptor ditches and random drains. Runoff can be controlled by establishing grassed waterways and by keeping a protective cover of plants on the soils at all times.

CAPABILITY UNIT IIe-2

In this capability unit are well-drained Abiqua and Willamette soils that have a surface layer of silty clay loam or silt loam and a subsoil of silty clay or silty clay loam. These soils have formed in alluvium on bottom lands and terraces. Slopes range from 3 to 12 percent. The annual precipitation is 40 to 60 inches, and the length of the frost-free season is generally about 190 to 210 days.

Permeability is moderate to moderately slow, and the available water capacity is high or very high. Fertility is high to moderate. The effective depth to which roots can penetrate is 5 feet or more. Runoff is medium, and the hazard of erosion is slight.

Soils of this unit are used mainly for cereal grains, orchards, forage crops, and grass grown for seed. When irrigated, they are used for vegetables, strawberries, caneberries, and many kinds of specialty crops.

Erosion can be controlled by farming across the slope, practicing rough tillage or mulching, properly managing crop residue, growing a cover crop, or using more than one of these practices. Runoff and erosion can also be controlled by properly managing crop residue and by using a cropping system in which grasses and legumes are grown at least 50 percent of the time. Drainageways normally do not cross these soils. Where drainageways are present, planting them to grass reduces the hazard of erosion.

Small grains and grasses respond to nitrogen fertilizer, row crops commonly respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on these soils also respond to lime.

Either sprinkler or furrow irrigation can be used for applying irrigation water. Irrigation increases the hazard of erosion. Therefore, water should be carefully applied, preferably by using sprinkler irrigation or the contour-furrow method, at rates low enough to prevent runoff. Water for irrigation is available from streams and wells.

CAPABILITY UNIT IIe-3

This capability unit consists of well-drained Hullt, Jory, McCully, Nekia, Salkum, and Silverton soils that have a surface layer of clay loam, silty clay loam, or silt loam, and a subsoil of silty clay loam, silty clay, or clay. These soils have formed on foothills and terraces in colluvium, glacial till, or alluvium. Slopes range from 2 to 12 percent. The annual precipitation is 40 to 75 inches, and the length of the frost-free season is 165 to 210 days.

Permeability is moderately slow or slow, and the available water capacity ranges from low to high. Fertility is low to moderate. The effective depth to which roots can penetrate ranges from about 10 to more than 60 inches. Runoff is slow. When the soils are in normal good tilth, erosion is only a slight hazard in cultivated areas and in areas seeded in fall.

When irrigated, these soils are suited to many different crops. They are used mainly for cereal grains, orchards, forage crops, and grass grown for seed.

Erosion can be easily controlled by fairly simple means, such as farming across the slope and, in addition, practicing rough tillage, growing a winter cover crop, or practicing stubble mulching. Returning all crop residue to the soils and using a cropping system in which grasses and legumes or grass-legume mixtures are grown at least 50 percent of the time are other practices that help to control erosion and that increase fertility and improve workability of the soils. Planting grass in the drainageways helps to prevent gullying.

Small grains and grasses respond to nitrogen fertilizer, row crops respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on these soils also respond to lime. Extra nitrogen fertilizer is needed if crop residue is plowed under.

Soils of this unit are usually not irrigated. If the soils are irrigated, either sprinklers or furrow irrigation can be used for applying the water. Irrigation increases the hazard of erosion. Therefore, water should be carefully applied, preferably by using sprinklers or by contour-furrow irrigation, at rates low enough that excess water does not run off. Water for irrigation is generally obtained from reservoirs. Few suitable sites for additional reservoirs are available.

CAPABILITY UNIT IIw-1

Somewhat poorly drained and moderately well drained McAlpin, Santiam, and Woodburn soils make up this capability unit. These soils have a surface layer of silty clay loam or silt loam and a subsoil of silty clay or silty clay loam. They have formed in alluvium on fans, bottom lands, and terraces. Slopes range from 0 to 3 percent. The annual precipitation is 40 to 60 inches, and the length of the frost-free season is 190 to 210 days.

Permeability is moderately slow or slow, and the available water capacity is high or very high. Fertility is moderate to high. The effective depth to which roots can penetrate ranges from about 2 to more than 5 feet. Runoff is slow. Erosion is not a hazard or is only a slight hazard if the soils are in good tilth and if rains are of normal intensity. Occasionally, these soils are wet as the result of a high water table.

These soils are better suited to row crops, forage crops, small grains, and grass grown for seed than to other crops, but they are also well suited to vegetables and to many of the specialty crops. The choice of crops is somewhat restricted, however, because of the occasional high water table. Long-lived, deep-rooted deciduous fruit trees and nut trees and strawberries, caneberries, and alfalfa are all unfavorably affected by wetness caused by the high water table.

Erosion is easily controlled. Returning all crop residue to the soils and using a cropping system in which grasses and legumes or grass-legume mixtures are grown at least 25 percent of the time help to reduce runoff and erosion. They also help to maintain favorable fertility and workability.

Small grains and grasses respond to nitrogen fertilizer, row crops respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur.

In many places legumes grown on these soils also respond to lime.

Water can be applied by using sprinkler, furrow, or border irrigation, but sprinkler irrigation is most commonly used and is satisfactory. Water should be carefully applied, and the rate of application should be low enough that runoff does not occur. Water for irrigation can be obtained from reservoirs or streams, but water for irrigating the McAlpin and Woodburn soils is generally obtained from wells. An adequate supply of water for irrigating the Santiam soil is not available from wells.

Wetness is a moderate limitation to use of these soils for crops. Drainage is needed if the soils are to be used to the maximum. In most places grid drainage will make the soils more suitable for crops. Seepage from higher areas can be controlled by installing interceptor ditches and random drains.

CAPABILITY UNIT IIw-2

The only soil in this capability unit is Amity silt loam. This soil is somewhat poorly drained and has slopes of 0 to 2 percent. It has formed in alluvium on broad valley terraces. The annual precipitation ranges from 40 to 45 inches, and the length of the frost-free season is 190 to 210 days.

Permeability is moderately slow, and the available water capacity is high. Fertility and the content of organic matter are both moderate. Runoff is slow. Erosion is not a hazard or is only a slight hazard where rains are of normal intensity and where this soil is in good tilth. The water table is high during some periods of the year.

Restricted drainage is a moderately severe limitation to use of this soil for crops. In undrained areas the seasonal high water table limits the choice of crops. Deep-rooted crops do not grow well, and most crops are adversely affected by the excess moisture. This soil can be used, however, for many row crops, and it can be used for forage crops, small grains, and grass grown for seed. Drained areas are better suited than are undrained areas to the crops commonly grown in the survey area, but deep-rooted crops and crops that cannot tolerate excess moisture still do not grow well.

Regular additions of organic matter are needed. Returning all crop residue to the soil and using a cropping system in which grasses and legumes or grass-legume mixtures are grown at least 25 percent of the time will help to reduce runoff and erosion, and they also help to maintain favorable soil fertility and workability.

Small grains and grasses respond to nitrogen fertilizer, row crops commonly respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on this soil also respond to lime.

Water can be applied by means of sprinkler, furrow, or border irrigation, but the sprinkler method is the most commonly used, and it is satisfactory. Irrigation water should be carefully applied and at a rate low enough that runoff does not occur. Adequate water for irrigation can generally be obtained from wells.

CAPABILITY UNIT IIw-3

Only one soil, Cloquato silt loam, which is well drained and is nearly level or gently undulating, is in this capability unit. This soil has a surface layer and a subsoil of silt loam. It is on flood plains, where it has formed in alluvium. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability is moderate, and the available water capacity is very high. Fertility is high. Flooding generally occurs only about once in 3 or 4 years, but it occurs two or three times in some years. Runoff is slow, but erosion is a slight to moderate hazard because of periodic overflow. Roots can penetrate to a depth of 5 feet or more.

This soil is suited to all the commonly grown crops that do not require harvesting late in fall. It is used mainly for row crops, forage crops, small grains, orchards, vegetables, grass grown for seed, and many specialty crops.

In some places dikes can be used to protect this soil from erosion that is caused by overflow. They are likely to increase the hazard of erosion, however, in years when floodwaters overflow the dikes. The hazard of erosion can be reduced, even in diked areas, by protecting this soil with a cover crop in winter and early in spring. Other practices that help to control erosion and that also help to maintain favorable soil fertility and workability consist of returning all crop residue to the soil and of using a cropping system that includes grasses and legumes or grass-legume mixtures grown at least 25 percent of the time.

Small grains and grasses respond to nitrogen fertilizer, row crops commonly respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on this soil also respond to lime.

Water can be applied either by using sprinkler or furrow irrigation. Sprinkler irrigation is the more satisfactory of the two methods. It does not require leveling, which can expose a rapidly permeable subsurface horizon. Adequate water for irrigating this soil is obtained from streams, sloughs, and shallow wells.

CAPABILITY UNIT IIw-4

Newberg fine sandy loam, which is somewhat excessively drained, is the only soil in this capability unit. This soil has a surface layer of fine sandy loam that is underlain by a substratum of sandy loam. It has formed in alluvium on flood plains. Slopes range from 0 to 3 percent. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability is moderately rapid, and the available water capacity is low. Fertility is moderate. Runoff is slow, and the hazard of erosion is moderate. Roots can penetrate to a depth of 5 feet or more.

This soil is used for row crops, forage crops, small grains, orchards, strawberries, caneberries, vegetables, grass grown for seed, and many of the specialty crops. These crops include many root crops that are harvested late in fall. All of the commonly grown crops that require good drainage grow well on this soil.

Erosion can be controlled in winter by growing an adequate cover crop or by leaving crop stubble on the surface. The hazard of erosion is increased by harvesting crops so late in fall that a cover crop cannot become established or attain adequate growth before cold weather. This soil should not be tilled or left bare in winter. In some areas dikes effectively protect this soil from flooding and the resulting erosion. Dikes increase the hazard of erosion, however, where floodwaters overflow the dikes. This soil can be protected and favorable fertility and workability can be maintained by properly managing crop residue and by using a cropping system in which grasses and legumes or grass-legume mixtures are grown at least 25 percent of the time.

Small grains and grasses respond to nitrogen fertilizer, row crops commonly respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on this soil also respond to lime.

Sprinklers are used for applying irrigation water. The low available water capacity and the moderately rapid to rapid movement of water through this soil make irrigation rather difficult. During the dry, warm summers, water must be applied frequently if an adequate supply of moisture is to be maintained for the growth of plants. In most places enough water for irrigation can be obtained from shallow wells or streams.

CAPABILITY UNIT IIw-5

McBee silty clay loam, which is moderately well drained, is the only soil in this capability unit. This soil has a surface layer and a subsoil of silty clay loam. It is on flood plains, where it has formed in alluvium. Slopes range from 0 to 5 percent. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability and fertility are both moderate, and the available water capacity is very high. Runoff is slow, and erosion is a moderate hazard. The depth to which roots can penetrate is restricted by a seasonal high water table.

This soil is better suited to row crops, forage crops, small grains, and grasses grown for seed than to other crops. It is used mainly for those crops and also for vegetables and for many specialty crops. Long-lived, deep-rooted deciduous fruit trees and nut trees and alfalfa and some other crops that require good drainage are adversely affected by excessive moisture, but fruit trees and alfalfa in other areas show no apparent ill effects.

Erosion can be controlled by keeping a cover crop or a cover of crop residue on the soil in winter and spring. In some places erosion caused by flooding can be controlled by constructing dikes. Dikes increase the hazard of erosion, however, in years when the floodwaters overflow the tops of the dikes. As in other areas, a cover crop or a cover of crop residue is needed to protect this soil in most of the diked areas. Properly managing crop residue and using a cropping system in which grasses and legumes or grass-legume mixtures are grown at least 25 percent of the time help to maintain fertility and favorable workability in addition to helping control runoff and erosion.

Small grains and grasses respond to nitrogen fertilizer, row crops commonly respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulphur. In many places legumes grown on this soil also respond to lime.

Either sprinkler or furrow irrigation is suitable. Sprinkler irrigation is more satisfactory because it does not require leveling that could expose a rapidly permeable layer in the substratum. Adequate water for irrigation is obtained from streams, sloughs, and shallow wells.

Drainage is needed for the lower lying areas. It is also needed for places where water seeps onto this soil from soils on adjacent terraces or from channels of old streams.

CAPABILITY UNIT IIw-6

The only soil in this capability unit is Newberg silt loam, which is somewhat excessively drained. This soil has a surface layer of silt loam that is underlain by a substratum of sandy loam. It has formed in alluvium on flood plains. Slopes range from 0 to 3 percent. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability is moderately rapid, and the available water capacity is low to moderate. Fertility is moderate. Runoff is slow, and erosion is a moderate hazard. Roots can penetrate to a depth of 5 feet or more.

This soil is well suited to all the commonly grown crops that require good drainage. It is used mainly for row crops, forage crops, small grains, orchards, strawberries, caneberries, vegetables, grass grown for seed, and many speciality crops.

This soil should not be tilled or left bare in winter. Erosion can be controlled during winter by growing a cover crop or by leaving stubble or other plant residue on the surface. Dikes have been constructed to protect some areas, but erosion is severe when floodwaters overflow the tops of the dikes. Properly managing crop residue and using a suitable cropping system are practices that not only help to control erosion but that also help to maintain favorable soil fertility and workability. A suitable cropping system is one in which grasses and legumes or grass-legume mixtures are grown at least 25 percent of the time.

Small grains and grasses respond to nitrogen fertilizer, row crops respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on this soil also respond to lime.

Sprinklers are used for applying irrigation water, but irrigation is somewhat difficult because moisture moves slowly through the silt loam surface layer. Over-irrigation is necessary, to some extent, so that moisture will move through the surface layer into the coarser textured material below. In summer, frequent irrigation is necessary to provide enough moisture for the growth of plants. As a rule, adequate water for irrigation is obtained from shallow wells or streams.

CAPABILITY UNIT IIs-1

Salem gravelly silt loam, which is well drained and nearly level, is the only soil in this capability unit. This soil has a subsoil of gravelly silty clay loam and a substratum of very gravelly sand. It has formed in gravelly alluvium on terraces. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability and fertility are both moderate, and the available water capacity is low. Runoff is slow, and erosion is not a hazard when this soil is in good tilth and when rains are of normal intensity. The effective depth to which roots can penetrate is restricted to 20 to 40 inches.

This soil is used mainly for row crops, forage crops, small grains, orchards, strawberries, caneberries, grass grown for seed, and a few of the specialty crops. When properly fertilized and irrigated, it is well suited to these crops.

In places the gravel in the surface layer makes cultivation rather difficult. The gravel in some areas reduces the available moisture capacity to the extent that this soil is slightly droughty. Properly managing crop residue and using a cropping system in which grasses and legumes are grown at least 25 percent of the time will help to maintain favorable fertility and workability.

Small grains and grasses respond to nitrogen fertilizer, row crops respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on this soil also respond to lime.

Sprinklers are used to apply irrigation water. Other methods of applying water are less desirable, because this soil is too shallow over the rapidly permeable substratum for leveling to be satisfactory. Deep cuts generally expose the substratum or the very gravelly lower part of the subsoil. Most areas of this soil are within an irrigation district or are adjacent to a stream that can be used to supply water for irrigation.

CAPABILITY UNIT IIIe-1

This capability unit consists of moderately well drained Santiam and Woodburn soils that have a surface layer of silt loam and a subsoil of silty clay loam. These soils are on terraces or terrace remnants, where they have formed in alluvium. They have slopes of 6 to 20 percent. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability is moderately slow or slow, and the available water capacity is high or very high. Fertility is moderate to high. Runoff is medium to rapid, and the hazard of erosion is moderate. The depth to which roots can penetrate is restricted to about 2 feet by a fluctuating water table during winter and spring.

These soils are as well suited to crops as the Santiam and Woodburn soils of capability unit IIe-1, but they are more susceptible to erosion. Some long-lived, deep-rooted deciduous fruit trees and nut trees and strawberries, raspberries, and alfalfa are adversely affected by excess moisture unless these soils are drained. These soils are better suited to forage crops, small grains, and grasses grown for seed than to other crops.

Erosion can be controlled by tilling across the slope, growing a winter cover crop, and establishing a permanent cover of grass in natural waterways. Properly managing crop residue and using a cropping system in which grasses and legumes or mixtures of grasses and legumes are grown at least two-thirds of the time help to reduce runoff and erosion, and they also help to maintain favorable fertility and workability.

Small grains and grasses respond to nitrogen fertilizer, row crops respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on these soils also respond to lime.

Irrigation is moderately difficult because of the strong slopes. Furthermore, water for irrigating the Santiam soil must be stored in reservoirs, although water for irrigating the Woodburn soil is generally available from wells. Sprinklers are suitable for applying irrigation water. Water should be applied at a rate low enough that it will soak into the soils without running off.

The strong slopes make these soils unsuitable for grid drainage. In most places drainage is provided by installing interceptor ditches and random drains.

CAPABILITY UNIT IIIe-2

This capability unit consists of moderately well drained and well drained soils of the Cumley, Horeb, Hullt, Jory, McCully, Nekia, Salkum, and Silverton series. These soils have a surface layer of loam, silt loam, silty clay loam, or clay loam and a subsoil of gravelly loam, silty clay loam, silty clay, or clay. They occur on foot slopes or terraces, where they have formed in colluvium, till, or alluvium. The annual precipitation is 40 to 90 inches, and the length of the frost-free season ranges from 120 to 210 days.

Permeability is moderate to slow, and the available water capacity ranges from low to high. Fertility is low to moderate. Runoff is medium, and the hazard of erosion is slight to moderate.

Soils of this unit are suited to many different crops, but they are used mainly for cereal grains, orchards, pasture, and grass grown for seed. In general, these soils are less fertile, less productive, and less easily tilled than soils on bottom lands and on younger terraces.

Erosion can be controlled by tilling across the slope, establishing grassed waterways, and growing a cover crop to protect these soils in winter. The cover crop should be planted early in fall so that it can make adequate growth before cold weather. Runoff and erosion can also be reduced and the favorable fertility and workability of the soils can be maintained by properly managing crop residue and by using a cropping system in which grasses and legumes or mixtures of grasses and legumes are grown at least two-thirds of the time.

Small grains and grasses respond to nitrogen fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on these soils also respond to lime.

On most of these soils, irrigation is difficult because of the strong slopes. Sprinklers are used for applying irrigation water, because the strong slopes in many places and the moderate hazard of erosion make other methods unsuitable. Water for irrigation is obtained mostly from reservoirs and ponds, but water for irrigating a small acreage is obtained from streams.

CAPABILITY UNIT IIIe-3

This capability unit consists of well drained and moderately well drained soils of the Hazelair and Steiwer series. These soils have formed in alluvium or colluvium on foot slopes or on low foothills adjacent to the valley floor. They have a surface layer of silt loam, have horizons of silty clay loam to clay just beneath the surface layer, and are underlain by sedimentary bedrock. Slopes range from 2 to 6 percent. The annual precipitation is 40 to 60 inches, and the length of the frost-free season is 190 to 210 days.

Permeability is slow or moderately slow, and fertility and the available water capacity are both low to moderate. The effective depth to which roots can penetrate ranges from 12 to 40 inches. Runoff is slow, and erosion is only a slight hazard where these soils have normal structure and are in good tilth. These soils tend to be slightly droughty. Droughtiness is a much greater hazard to crops in years when rains are lacking late in spring than in other years.

These soils are less well suited to crops than other soils on foothills, but they are used for small grains, pasture, hay, and grass grown for seed. In addition, small areas are used for pole beans, sweet corn, strawberries, and caneberries. Fruit trees and deep-rooted crops are not grown, because these soils are too shallow over bedrock and are too inclined to be droughty.

Erosion is easily controlled by establishing grassed waterways and farming across the slope if, in addition, crop residue is used to protect the soils in winter, rough tillage or stubble mulching is practiced, or a winter cover crop is grown. The cover crop should be planted early in fall so that it can make adequate growth before cold weather. Properly managing crop residue and using a cropping system in which grasses and legumes or mixtures of grasses and legumes are grown at least 25 percent of the time not only reduce runoff and erosion, but they also help to maintain favorable fertility and workability of the soils.

Small grains and grasses respond to nitrogen fertilizer, row crops commonly respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on these soils also respond to lime. Where stubble mulching is practiced, additional nitrogen is needed.

Soils of this unit are usually not irrigated. Water for irrigation must be stored in reservoirs, and adequate sites for reservoirs are lacking. Where the soils are irrigated, spinklers are suitable for applying water. Using excessive water or applying water at an excessive rate should be avoided to prevent runoff and seepage.

CAPABILITY UNIT IIIe-4

This capability unit consists of well-drained Horeb, McCully, and Nekia soils that have a surface layer of gravelly silt loam, stony clay loam, or stony silty clay loam. These soils are on low foothills and on mountainous foot slopes, where they have formed in colluvium or till. They have slopes of 0 to 20 percent. The annual precipitation is 40 to 90 inches, and the length of the frost-free season is 120 to 210 days.

Permeability is moderate or moderately slow, and fertility and the available water capacity are both low to moderate. The effective depth to which roots can penetrate ranges from 20 to more than 60 inches. Runoff is slow to medium, and the hazard of erosion is slight or moderate. In years when precipitation is below normal, the shallower soils are droughty.

These soils are used mainly for pasture, for grass grown for seed, and as woodland. They are also suitable for small grains, hay, and orchards, but lack of adequate moisture and the moderate difficulty of farming the strongly sloping areas make the soils less suitable for most other crops. Where the soils have been smoothed and floated for harvesting of nuts, they are not suitable for filberts and walnuts.

Erosion can be controlled by farming across the slope, establishing grassed waterways, and growing a winter cover crop. The cover crop should be planted early in fall so that the plants will have time to make adequate growth before cold weather.

Small grains and grasses respond to nitrogen fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on these soils also respond to lime.

Soils of this unit are seldom irrigated. Where the soils are irrigated, sprinklers should be used for applying water, and the water should be applied at a low enough rate so that runoff is avoided. Unless a water right from a stream has been granted, water for irrigation generally must be stored in reservoirs.

CAPABILITY UNIT IIIe-5

Chehalem silt loam, 2 to 12 percent slopes, which is somewhat poorly drained, is the only soil in this capability unit. This soil has formed in alluvium on alluvial fans. It has a surface layer of silt loam and a subsoil of silty clay. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability is slow, and the available water capacity is high. Fertility is moderate. Runoff is medium, and the hazard of erosion is slight.

Erosion can be controlled by farming across the slope and growing a winter cover crop, or by establishing interceptor ditches and practicing rough tillage. Establishing grassed waterways also helps to reduce erosion. Properly managing crop residue and using a cropping system in which grasses and legumes or mixtures of grasses and legumes are grown at least 50 percent of the time help to reduce runoff and erosion, and they help to maintain the favorable fertility and workability of this soil.

Small grains and grasses respond to nitrogen fertilizer, row crops commonly respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on this soil also respond to lime.

This soil is usually not irrigated. A reservoir is needed for storing water for irrigation, and a suitable site for a reservoir is lacking in most places.

Drainage is needed for maximum use of this soil. Although this soil is easily drained, erosion is a hazard in open drainage ditches, unless care is taken in laying out the ditches. In most places drainage can be accomplished by installing interceptor drains and by providing random lines that will drain wet spots in the lower lying areas. Open ditches or grassed waterways can be used to intercept runoff from higher areas.

CAPABILITY UNIT IIIe-6

This capability unit consists of well-drained Jory, McCully, and Nekia soils that have slopes of 7 to 12 percent. These soils have a surface layer of silty clay loam or clay loam, and a subsoil of clay. They occur on low foothills along the margins of mountainous foot slopes, where they have formed in colluvium or till. The annual precipitation is 40 to 75 inches, and the length of the frost-free season is 165 to 210 days.

Permeability is moderately slow, and fertility and the available water capacity are both low to moderate. The effective depth to which roots can penetrate is 20 to more than 60 inches. Runoff is medium, and erosion is a moderate hazard.

In general, the soils of this unit are less fertile, less easily tilled, and less well suited to crops than soils on bottom lands and terraces. They are suited to many different crops, however, and they are used mainly for cereal grains, orchards, pasture, and grass grown for seed.

Erosion can be controlled by farming across the slope, establishing grassed waterways, and growing a winter cover crop. The cover crop should be planted early in fall so that the plants can attain adequate growth before cold weather. Properly managing crop residue and using a suitable cropping system also help to reduce runoff and erosion, and they help to maintain favorable fertility and workability of the soils. The cropping system should include grasses and legumes, or a mixture of grasses and legumes, grown at least two-thirds of the time.

Small grains respond to nitrogen fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on these soils also respond to lime.

For the soils of this unit, the moderate slopes and hazard of erosion make irrigation fairly difficult. These soils are well suited to sprinkler irrigation, however, and that is the method generally used. Water for irrigation is obtained mainly from farm reservoirs and ponds, but water for irrigating a small acreage is obtained from streams.

CAPABILITY UNIT IIIw-1

This capability unit consists of nearly level, somewhat poorly drained Clackamas and Holcomb soils that have a surface layer of gravelly loam or silt loam and a subsoil of clay or gravelly clay loam. These soils are on terraces, and they have formed in alluvium. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability is moderately slow to very slow, and fertility is moderate. Within the root zone, the available water capacity is low. The effective depth to which roots can penetrate is restricted to 20 to 30 inches by a fluctuating water table or by a layer of very slowly permeable material. Runoff is slow. Erosion is only a slight hazard when the soils are in good tilth and when rains are of normal intensity. These soils are droughty during dry periods in summer.

The Clackamas soil is used mainly for small grains, forage crops, sweet corn, pole beans, bush beans, and grass grown for seed. The Holcomb soil is used mainly for pasture and for grass grown for seed.

Proper management of crop residue and use of a suitable cropping system are needed to maintain favorable fertility and workability of the soils. The cropping system should include grasses and legumes or a mixture of grasses and legumes grown at least 25 percent of the time.

Small grains and grasses respond to nitrogen fertilizer, row crops commonly respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and lime. In many places legumes grown on these soils also respond to lime.

During dry weather in summer, irrigation is needed for vegetables grown on these soils. Irrigation water must be applied frequently, even where the soils are drained or are of limited depth and of limited available water capacity. Most areas of these soils are in an irrigation district or are near a stream where some water rights are available.

Drainage is needed to make these soils better suited to crops. Providing drainage is difficult because of the very slowly permeable layer in the subsoil, and because of the lack of adequate outlets.

The gravelly surface layer of the Clackamas soil is a moderate limitation to use of that soil for crops that require tillage. This soil does not compact under severe use. It is in good tilth, except for the gravel. The Holcomb soil tends to compact under severe use, or if it is cultivated when too moist.

CAPABILITY UNIT IIIw-2

This capability unit consists of poorly drained Concord, Labish, Waldo, and Wapato soils that have slopes of 0 to 2 percent. These soils have a surface layer of silt loam or silty clay loam and a subsoil of silty clay loam, silty clay, or clay. They have formed in alluvium and are on flood plains, on the bottoms of former lakes, in depressions, and in drainageways of broad valley terraces. The annual precipitation is 40 to 60 inches, and the length of the frost-free season is 190 to 210 days.

Permeability is slow or moderately slow, and the available water capacity is high or very high. Fertility ranges from low to high. Runoff is slow to ponded, and the hazard of erosion is only slight. The effective depth to which roots can penetrate is restricted by a seasonal high water table.

Soils of this unit are used mainly for small grains, pasture, and hay. When irrigated, small acreages that are drained are used for vegetables and specialty crops. As a rule, these soils are not suitable for deep-rooted perennial crops, because adequate outlets usually cannot be maintained in winter and spring.

Erosion caused by seasonal overflow and runoff from higher areas can be controlled by growing a winter cover crop each year and by properly managing crop residue. Proper management of crop residue and use of a cropping system in which grasses and legumes or mixtures of grasses and legumes are grown at least 25 percent of the time also help to maintain favorable fertility and workability of the soils.

Small grains and grasses respond to nitrogen fertilizer, row crops commonly respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on these soils also respond to lime.

Irrigation is needed for best returns from all crops, and it is necessary if vegetables are to be grown commercially. Especially on the Concord soil, water should be applied in small enough amounts that the soils are not overirrigated and a water table does not develop. In most places water is available from streams, wells, and ponds.

Drainage is needed if these soils are to be used to the maximum. Providing drainage is difficult in most areas because outlets are poor and seasonal overflow occurs; these soils are also periodically flooded by water that flows from higher areas. Response to drainage is good where adequate outlets are provided.

CAPABILITY UNIT IIIw-3

Semiahmoo muck is the only soil in this capability unit. This soil is poorly drained and is nearly level. It has formed on the bottoms of former shallow lakes. The upper part of the profile is muck, and the lower part is peat. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability is moderate, and the available water capacity is very high. Runoff is slow, and erosion is a moderate hazard. The depth to which roots can penetrate is limited by a high water table.

This soil is used mainly for growing onions. Small acreages are used for mint, small grains, vegetables, sweet corn, pasture, and hay.

Erosion can be controlled by growing a winter cover crop. Proper management of crop residue and use of a cropping system in which grasses and legumes or mixtures of grasses and legumes are grown at least 50 percent of the time also help to control erosion, and they provide regular additions of organic matter. Fire is a hazard during dry weather in summer, when the water table is low.

Fertilizer and amendments are best applied according to the needs of the crop to be grown. Excessive use of fertilizer or amendments increases the decomposition of the organic matter.

Irrigation is needed during dry weather in summer. Water for irrigation is readily available from drainage ditches and shallow wells.

To minimize subsidence, the water table must be maintained at a fairly high level. Drainage is needed if this soil is to be used for cultivated crops, but the drains should be only deep enough for crops to be grown. Drainage ought to be maintained only through the growing and harvesting seasons.

CAPABILITY UNIT IIIs-1

Sifton gravelly loam, which is excessively drained and nearly level, is the only soil in this capability unit. This soil has a surface layer and a subsoil of gravelly loam and a substratum of very gravelly sand. It is on terraces and has formed in gravelly alluvium. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability is moderately rapid in the surface layer and the subsoil, and it is very rapid in the substratum. Fertility and the available water capacity are both low. The effective depth to which roots can penetrate is 20 to 30 inches. Runoff is very slow, and erosion is not a hazard. Droughtiness is a hazard to crops.

This soil is used mainly for bush beans, pole beans, sweet corn, caneberries, small grains, and forage crops. It is not suitable for many root crops.

This soil warms up early in spring, probably because of its dark color, porosity, and high content of gravel. In most areas the cobblestones and larger pebbles have been picked up to make this soil easier to work. Soil tilth and the rate of infiltration are not changed appreciably by cultivation.

Favorable fertility and desirable soil tilth can be maintained by properly managing crop residue, by using a suitable cropping system, by growing a green-manure crop of rye or other cereal grain each year, and by occasionally growing a legume. The cropping system should include grasses and legumes or mixtures of grasses and legumes grown at least 25 percent of the time.

Small grains and grasses respond to nitrogen fertilizer, row crops commonly respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on this soil also respond to lime.

Irrigation is needed for all crops, and it is essential if vegetables and berries are to be grown. Sprinklers should be used for applying irrigation water. Frequent applications of water are needed during dry weather in summer. This soil is within an irrigation district. Therefore, water for irrigation is available.

CAPABILITY UNIT IVe-1

This capability unit consists of Horeb, Hullt, Jory, McCully, and Nekia soils that are well drained and that have slopes of 2 to 35 percent. These soils have a surface layer of gravelly silt loam, clay loam, or silty clay loam, and lower layers of silty clay loam, clay, and gravelly or cobbly loam to very gravelly sand. They occur on mountain foot slopes and on low, red foothills, where they have formed in till and colluvium, mainly derived from basalt and sandstone. The annual precipitation ranges from 40 to 90 inches, but it is generally between 40 and 75 inches. The length of the frost-free season ranges from 120 to 210 days, but it is between 165 and 210 days in most years.

Permeability is moderate to slow, fertility is moderate or low, and the available water capacity ranges from low to high. The effective depth to which roots can penetrate is 20 to more than 60 inches. Runoff is rapid or medium, and the hazard of erosion is severe or moderate.

Soils of this unit are used mainly as woodland and for pasture, hay, and grass grown for seed. In addition, small acreages are used for orchards, small grains, strawberries, and caneberries.

Intensive management is needed to protect these soils if cultivated crops are grown. Establishing grassed waterways, practicing field stripcropping, and growing a cover crop or practicing rough tillage between the strips all help to control erosion. Farming on the contour, protecting the soils with a cover crop in winter, and establishing grassed waterways are also effective practices for controlling erosion, but in many areas the length and shape of the slopes are not suitable for contouring. Properly managing crop residue and using a suitable cropping system will help to reduce runoff and erosion, and they also help to maintain soil fertility and favorable workability. The cropping system should include grasses and legumes or mixtures of grasses and legumes grown at least 75 percent of the time.

Small grains and grasses respond to nitrogen fertilizer, row crops respond to nitrogen and phosphorus fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on these soils also respond to lime.

These soils are generally not irrigated, and they require careful management if they are irrigated. The rate at which water is applied must be such that little or no runoff occurs. Only sprinklers are used for irrigation, and they are difficult to use because of the strong slopes in many places. Water for irrigation is available only from reservoirs and ponds.

CAPABILITY UNIT IVe-2

This capability units consists of well drained and moderately well drained soils of the Hazelair and Steiwer series. The surface layer of these soils is silt loam, and the lower horizons are silty clay loam to clay over sedimentary bedrock. These soils are on foot slopes or low foothills adjacent to the valley floor, where they have formed in alluvium or colluvium. Slopes range from 6 to 20 percent. The annual precipitation is 40 to 60 inches, and length of the frost-free season is 190 to 210 days.

Permeability is slow or moderately slow, and fertility and the available water capacity are both low to moderate. The effective depth to which roots can penetrate ranges from about 12 to 40 inches. Runoff is medium, and the hazard of erosion is moderate.

Soils of this unit are used mainly for small grains, pasture, hay, and grass grown for seed. Their limited depth over bedrock and their tendency to droughtiness make them unsuitable for fruit trees and deep-rooted crops.

Erosion can be controlled by establishing grassed waterways, farming across the slope, properly managing crop residue, using a suitable cropping system, and planting a winter cover crop. The cover crop should be planted early in fall so that the plants can make adequate growth before cold weather. Practices used to reduce runoff and erosion also help to maintain favorable fertility and workability of the soils. The cropping system should include grasses and legumes or mixtures of grasses and legumes grown at least 50 percent of the time.

Small grains and grasses respond to nitrogen fertilizer. Extra nitrogen is needed when crop residue is turned under. Legumes respond to phosphorous fertilizer and sulfur. In many places legumes grown on these soils also respond to lime.

These soils are usually not irrigated. When they are irrigated, sprinklers are used for applying water. Excessive irrigation should be avoided so that runoff will be prevented. Water for irrigation is stored in reservoirs and ponds.

CAPABILITY UNIT IVw-1

This capability unit consists of poorly drained Courtney and Dayton soils that have a surface layer of silt loam or gravelly silty clay loam and a subsoil of clay or gravelly clay. These soils are in shallow depressions and in drainageways, and they have formed in alluvium. Slopes are 0 to 2 percent. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 190 to 210 days.

Permability is very slow, and fertility is moderate or low. The available water capacity is low or very low to a depth of 60 inches or more. Runoff is ponded to very slow, and the hazard of erosion is slight. The effective depth to which roots can penetrate is 12 to 24 inches.

These soils are used mainly for small grains, pasture, hay, and grass grown for seed. When irrigated, small areas that are in fields with other soils more suitable for crops are drained and are used for sweet corn, pole beans, and caneberries. These soils are not suited to deep-rooted crops or to crops that cannot tolerate excess moisture.

Erosion is not a hazard, except where water concentrates as the result of drainage. It can be controlled by properly managing crop residue, protecting the soils with a winter cover crop, and using a cropping system in which grasses and legumes or mixtures of grasses and legumes are grown at least 25 percent of the time. Practices used to control erosion also help to maintain favorable fertility and workability of the soils.

Droughtiness is a hazard to crops during dry weather in summer. When the soils are irrigated, care must be taken to prevent overirrigation and drowning of the crop. Water for irrigating the Dayton soil is available from wells. The Courtney soil is within an irrigation district.

Drainage is needed if the soils of this unit are to be used to the maximum. It is difficult to establish, however, because of the inadequate outlets and because of the very slowly permeable clay near the surface. Tile should be placed at close intervals below the clay subsoil. For immediate drainage, the tile should be blinded by placing a filter in the layer of clay. Even after the soils are drained, control of the water table is difficult.

CAPABILITY UNIT IVw-2

Bashaw clay, which is poorly drained or very poorly drained, is the only soil in this capability unit. This soil has formed in alluvium in backwater areas of the flood plains and in drainage channels of silty terraces. The clay surface layer rests directly on a clay substratum. Slopes are between 0 and 1 percent. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability is very slow, and the available water capacity is moderate to high. Fertility is moderate. Runoff is very slow to ponded, and erosion is only a slight hazard.

This soil is better suited to forage crops that can tolerate excess moisture than to other crops. It is used mainly for pasture, hay, and grass grown for seed. Small areas have been smoothed and are used for spring small grains.

Erosion is generally not a hazard in the backwater areas where this soil occurs. Crops are likely to be damaged by deposition or by excess water, however, and a crop can be drowned. Some areas that are subject to deposition can be protected by establishing interceptor ditches, by providing adequate outlets, and by establishing drainageways.

Small grains and grasses respond to nitrogen fertilizer, and legumes respond to phosphorus fertilizer and sulfur. In many places legumes grown on this soil also respond to lime.

Properly managing crop residue and using a cropping system in which grasses and legumes or mixtures of grasses and legumes are grown at least 25 percent of the time help to maintain favorable fertility, and they make this soil easier to work.

When this soil is dry, it is subject to cracking. After cracks form, water is readily taken in until the soil is saturated. The soil swells as water is taken in, and as a result, the cracks close. Because of this alternate shrinking and swelling, irrigation is very difficult. The intake rate ranges from rapid to very slow, depending upon the amount of moisture in the soil. Once the soil is saturated, little additional water enters until the soil again dries out and cracks. Maintaining a favorable air-moisture relationship is difficult.

Drainage is needed, but because this soil is clayey and is structureless (massive), drainage is largely confined to removing excess surface water. In most places smoothing the surface and establishing outlets to help remove excess water is about all that can be done to improve drainage.

Cultivating this soil and preparing an adequate seedbed are difficult. Tillage can be performed only within a narrow range of moisture content.

CAPABILITY UNIT IVw-3

Only Camas gravelly sandy loam, which is excessively drained and has slopes of 0 to 3 percent, is in this capability unit. This soil has a surface layer of gravelly sandy loam and a subsoil of very gravelly sand. It has formed in alluvium on bottom lands. The annual precipitation is 40 to 45 inches, and the length of the frost-free season is 200 to 210 days.

Permeability is very rapid, and the available water capacity is very low. Fertility is low. Runoff is very slow, and erosion is only a slight hazard. Overflow is a hazard in some areas.

When irrigated, this soil is used for all the crops commonly grown in the survey area. It is used mainly for small grains, for pasture, or as woodland when not irrigated. This soil is poorly suited to many of the commonly grown crops. It occupies small areas within larger areas of bottom-land soils that are better suited to crops, however, and it is used the same as the better suited soils.

Erosion can be controlled by growing a winter cover crop. This crop should be planted early in fall to allow adequate time for roots to become established and top growth to be made before the period of overflow. In many years fertilization and irrigation are necessary if a crop is to be established early in fall. Stubble and other plant residue should be left on this soil over winter, and then turned under in spring. Returning all crop residue to the soil and using a cropping system in which grasses and legumes or grass-legume mixtures are grown at least 25 percent of the time not only help to control erosion, but they also help to maintain desirable soil fertility and help to keep this soil in good tilth.

The low available water capacity of this soil and the high infiltration rate make irrigation difficult. Sprinklers are used for applying irrigation water. More frequent applications of water are needed than on less gravelly soils, and the water should be applied for shorter periods of time. As this soil is presently managed, plants rarely receive adequate water for good growth. As a result, crops are generally stunted, because the amount of soil moisture is usually below the wilting point of most plants. Water for irrigation is normally obtained from streams or from shallow wells.

The gravel in the surface layer and in the underlying material makes tillage and preparation of the seedbed difficult. In many places the cobblestones and larger pebbles have been removed to make this soil suitable for tillage.

CAPABILITY UNIT VIe-1

This capability unit consists of well drained and moderately well drained soils of the Hazelair, Stayton, Steiwer, and Chehulpum series. Some of these soils have a surface layer and a subsoil of silt loam; others have a surface layer of silt loam and a subsoil of silty clay loam; and still others have a surface layer of silty clay loam over a subsoil of clay. These soils are on foot slopes and foothills, where they have formed in alluvium and colluvium underlain by sandstone and shale or basalt. Slopes range from 0 to 40 percent. The annual precipitation is 40 to 60 inches, and the length of the frost-free season is 190 to 210 days.

Permeability is moderate to slow, and the available water capacity is very low or low. Fertility is moderate or low. The effective depth to which roots can pentrate is 10 to 24 inches. Runoff is medium to rapid, and erosion is a moderate to severe hazard.

Soils of this unit are not suitable for cultivated crops, and they are used mainly for pasture, for grass grown for seed, and as woodland. Oak is the dominant species of tree. Douglas-fir grows in places where some deposition has occurred, or where areas of deeper soils are included with these soils. It makes only poor growth.

Because of lack of moisture, these soils are generally not fertilized extensively. Small amounts of fertilizer are applied early in spring or in fall.

A permanent cover of plants should be kept on these soils. Improved varieties of grasses are desirable for cover if they can be established. Planting improved varieties of grasses early in spring insures a more nearly adequate cover than where these grasses are planted later, and this cover will help to protect the soils from erosion the following winter. These soils are droughty. Grasses make little or no growth late in summer and in fall.

Irrigation of these soils is limited. When the soils are irrigated, the water should be carefully applied so as to prevent runoff. Water for irrigation must be stored in reservoirs.

CAPABILITY UNIT VIe-2

This capability unit consists of Terrace escarpments and of well-drained Hullt, Kinney, McCully, Nekia, and Whetstone soils. These soils have a surface layer of loam, clay loam, or silty clay loam and a subsoil of loam, silty clay loam, or clay. They occur on mountain foot slopes, on low foothills, and on escarpments of terraces, where they have formed in colluvium that was derived mainly from basalt and sandstone. Slopes range from 2 to 60 percent. The annual precipitation is 40 to 90 inches, and the length of the frost-free season is 90 to 210 days.

Permeability is moderately slow or moderate, and the available water capacity ranges from low to high. Fertility is moderate or low. Runoff is medium to very rapid, and the hazard of erosion is slight to severe.

All of these soils, except Terrace escarpments, are used primarily for growing Douglas-fir to which the soils are well suited. Terrace escarpments is suitable either for use as woodland or for pasture. A large acreage of Hullt, McCully, and Nekia soils is used for woodland pasture. Minor acreages of these soils are used for improved pasture and for grass grown for seed, uses to which these soils are poorly suited. The Kinney and Whetstone soils are suitable only for growing timber.

Tillage and other management practices needed for establishing and maintaining improved pasture on the Hullt, Kinney, and McCully soils are difficult to apply where the slopes exceed 30 percent. Where slopes are steeper than 40 percent, these practices generally are not feasible. Where these soils are used for improved pasture, the grass should be planted early in spring so that the plants can make adequate growth before they are exposed to winter rains. Because trees are the climax vegetation on the soils of this unit, and natural regeneration of trees permits only a transitory establishment of native grasses, use of these soils for pasture entails a constant battle against the encroachment of trees.

CAPABILITY UNIT VIw-1

Minniece silty clay loam, 0 to 8 percent slopes, which is somewhat poorly drained and poorly drained, is the only soil in this capability unit. This soil has a surface layer of silty clay loam and a subsoil of clay. It is in seepage areas and in drainage channels, where it has formed in colluvium and alluvium. The annual precipitation is 60 to 90 inches. Length of the frost-free season is 145 to 190 days.

Permeability is very slow, fertility is low, and the available water capacity is high. Runoff is slow to medium. Erosion is only a slight hazard.

This soil is not used for cultivated crops. It is wooded and is used mainly for growing alder and maple. Erosion can be controlled by maintaining a good cover of plants in the understory and by logging only in summer.

CAPABILITY UNIT VIs-1

Well-drained, very stony Henline, McCully, Nekia, and Witzel soils are in this capability unit. These soils have formed in colluvium or glacial till, and they occur on low foothills and on mountainous uplands. Slopes range from 3 to 55 percent. The annual precipitation is 40 to 90 inches, and the length of the frost-free season is 90 to 210 days.

Permeability ranges from moderately rapid to moderately slow, and the available water capacity ranges from very low to moderate. Fertility is low to moderate. The effective depth to which roots can penetrate ranges from about 12 to more than 60 inches. Runoff is medium to rapid, and the hazard of erosion ranges from slight to severe.

Soils of this unit are used mainly for growing Douglas-fir, but substantial amounts of noble fir, silver fir, and hemlock are produced on the Henline soils. All of the soils, except the Witzel, are well suited or moderately well suited to Douglas-fir, but the Witzel soil is poorly suited. These soils are not suitable for improved pasture, but some areas of McCully, Nekia, and Witzel soils are used for woodland pasture.

CAPABILITY UNIT VIIe-1

This capability unit consists of well-drained Kinney, McCully, and Whetstone soils that have slopes of 50 to 75 percent. These soils have a surface layer of clay loam, cobbly loam, or stony loam and a subsoil of cobbly clay loam. They are on mountainous foot slopes and along the margins of those foot slopes, where they have formed in till or colluvium. The annual precipitation is 60 to 90 inches, and the length of the frost-free season is 90 to 190 days.

Permeability is moderately slow to moderate, and the available water capacity is moderate to high. Fertility is low to moderate. The effective depth to which roots can penetrate is 40 to 60 inches or more. Runoff is very rapid, and the hazard of erosion is very severe.

Soils of this unit are unsuitable for cultivated crops, because of their steep slopes. They are used mainly for growing Douglas-fir, but a minor acreage is in hemlock.

Management practices other than providing protection from fire, controlling diseases of the trees, and aerial seeding are not feasible, because of the steep slopes. Erosion can be controlled by maintaining an adequate cover of plants on the soils during logging and by using a high lead for logging. Water-control structures are needed on the logging roads.

CAPABILITY UNIT VIIw-1

This capability unit consists only of Alluvial land. This miscellaneous land type is comprised of loose sand, silty material, gravel, and cobblestones deposited by streams. It is subject to frequent change as the result of stream overflow.

This land type is unsuitable for cultivated crops, because of the annual overflow and the hazard of erosion. It can be used for wildlife habitat and recreation, and it also has esthetic value and has limited use as woodland. If carefully managed, the natural stands of cottonwood and Douglas-fir can be made to produce wood products.

CAPABILITY UNIT VIIs-1

This capability unit consists of only one soil, Henline very stony sandy loam, 55 to 80 percent slopes. This soil has formed in colluvium, and it occurs on mountainous foot slopes. The annual precipitation is 70 to 90 inches, and the length of the frost-free season is 90 to 110 days.

Permeability is moderately rapid, and the available water capacity is very low. Fertility is low. The effective depth to which roots can penetrate is 20 to 40 inches. Runoff is very rapid, and the hazard of erosion is very severe.

This soil is used mainly for growing Douglas-fir, but a minor acreage is used for growing noble fir, silver fir, and hemlock. Applying management practices other than aerial seeding and practices that provide protection from fire and help to control diseases is not feasible, because of the cobblestones, other stones, and steep slopes. Erosion can be controlled by maintaining an adequate cover of plants on this soil during logging operations and by using a high lead for logging. Water-control structures are needed on the logging roads.

CAPABILITY UNIT VIIIs-1

This capability unit consists only of Stony rock land. This miscellaneous land type is stony, contains many rock outcrops, and is very shallow over bedrock. Slopes range from 1 to 80 percent.

Runoff is medium to rapid, and the hazard of erosion is severe. The available water capacity is very low.

This land type is suitable for wildlife habitat and watershed, and it also has esthetic value. It can be protected from accelerated erosion by maintaining the natural cover of plants.

Predicted yields and management by crop [2]

In this part of the survey, predicted average acre yields are given for some of the principal irrigated and dryland crops commonly grown in the survey area. Also given are practices needed to obtain these yields.

Table 1 shows, for most of the soils in the survey area, the predicted average acre yields obtainable under a high level of management from a few irrigated and dryland crops commonly grown in the survey area. A high level of management consists of farming practices that research, field trials, and experience indicate produce the highest net returns. These estimates are based on interviews with farmers, and on information supplied by soil scientists and other agricultural workers who are familiar with the soils and crops of the Marion County Area.

In any given year, yields may be higher or lower than the average maximum yields shown in table 1, and variations in the water-supplying capacity and fertility also can cause the yields on similar soils to differ in the same locality. Future improvements in technology are expected to make these yield estimates obsolete.

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[2] BILLIE C. COX, Soil Conservation Service, assisted in preparing this subsection.

TABLE 1.—*Predicted average acre yield of principal irrigated and dryland crops under a high level of management*

[Absence of a yield value indicates that the soil is not suited to the crop, or that the crop is not ordinarily grown on the soil]

Soil	Irrigated crops					Dryland crops					
	Pole beans	Blackberries	Sweet corn	Pasture	Strawberries	Alfalfa	Bentgrass seed	Sweet cherries	Filberts	Spring barley	Winter wheat
	Tons	*Tons*	*Tons*	*AUM*[1]	*Tons*	*Tons*	*Cwt.*	*Tons*	*Tons*	*Cwt.*	*Cwt.*
Abiqua silty clay loam, 0 to 3 percent slopes	12	5	8	21	6	6	4.5	4.4	1.3	38	42
Abiqua silty clay loam, 3 to 5 percent slopes	12	5	8	21	6	6	4.5	4.4	1.3	38	42
Amity silt loam[2]	11	5	8	21	5	6	4	3.5	.8	38	39
Bashaw clay[2]	-	-	-	12	-	-	3	-	-	21	-
Camas gravelly sandy loam	-	-	-	12	-	-	-	-	-	16	21
Chehalem silt loam, 2 to 12 percent slopes[2]	10	4	6	18	5	4	3	3	.8	24	33
Chehalis silty clay loam	12	5	8	21	6	6	4.5	4.4	1.3	38	42
Clackamas gravelly loam[2]	10	4	6	18	5	3.5	3.5	-	-	28	33
Cloquato silt loam	12	5	8	21	6	6	4.5	4.4	1	38	45
Concord silt loam[2]	10	4	6	18	-	-	4	-	-	24	36
Courtney gravelly silty clay loam[2]	-	-	5	15	-	-	3	-	-	24	21
Dayton silt loam[2]	-	-	5	15	-	-	3	-	-	24	21
Hazelair silt loam, 2 to 6 percent slopes	9	4	6	15	5	-	2.75	-	-	24	32
Hazelair silt loam, 6 to 20 percent slopes	-	-	-	15	5	-	2.75	-	-	24	32
Hazelair silty clay loam, 2 to 15 percent slopes, eroded	-	-	-	12	-	-	-	-	-	-	-
Holcomb silt loam[2]	10	4	6	18	-	-	3.5	-	-	28	36
Horeb loam, 2 to 20 percent slopes	-	-	-	18	-	4.5	4	-	-	24	33
Horeb gravelly silt loam, gravelly substratum, 0 to 15 percent slopes	-	-	-	15	-	-	3.5	-	-	24	-
Horeb gravelly silt loam, gravelly substratum, 15 to 35 percent slopes	-	-	-	15	-	-	-	-	-	-	33
Hullt clay loam, 2 to 7 percent slopes	10	4	6	18	5	4.5	4	4	.9	24	33
Hullt clay loam, 7 to 20 percent slopes	10	4	-	18	5	4.5	4	4	.9	24	33
Hullt clay loam, 20 to 30 percent slopes	-	-	-	18	-	4.5	-	4	-	24	33
Hullt clay loam, 30 to 60 percent slopes	-	-	-	18	-	-	-	-	-	-	-
Jory silty clay loam, 2 to 7 percent slopes	10	4	6	18	5	4.5	4	4.4	1.3	24	33
Jory silty clay loam, 7 to 12 percent slopes	10	4	6	18	5	4.5	4	4.4	1.3	24	33
Jory silty clay loam, 12 to 20 percent slopes	10	4	-	18	5	4.5	4	4.4	1.3	24	33
Jory silty clay loam, 20 to 30 percent slopes	-	-	-	18	-	4.5	4	4.4	-	24	33
Labish silty clay loam[2]	10	4	6	15	-	-	4	-	-	24	36
McAlpin silty clay loam, 0 to 3 percent slopes[2]	11	5	8	21	5	6	4	4.4	1.2	38	36
McAlpin silty clay loam, 3 to 6 percent slopes	11	5	8	21	5	6	4	4.4	1.3	38	36
McBee silty clay loam	12	5	8	21	5	6	4.5	4.4	1.2	38	39
McCully clay loam, 30 to 50 percent slopes	-	-	-	18	-	-	-	-	-	-	-
McCully clay loam, 2 to 7 percent slopes	10	4	6	18	5	4.5	4	4	1	24	33
McCully clay loam, 7 to 12 percent slopes	10	4	-	18	5	4.5	4	4	1	24	33
McCully clay loam, 12 to 20 percent slopes	10	4	-	18	5	4.5	4	4	1	24	33
McCully clay loam, 20 to 30 percent slopes	-	-	-	18	-	4.5	4	4	-	24	33
McCully stony clay loam, 2 to 20 percent slopes	-	-	-	16	-	3.5	3.5	3.5	-	24	33 33
Nekia silty clay loam, 2 to 7 percent slopes	10	4	6	18	5	4.5	4	4	1	24	33
Nekia silty clay loam, 7 to 12 percent slopes	10	4	-	18	5	4.5	4	4	1	21	33
Nekia silty clay loam, 12 to 20 percent slopes	10	4	-	18	5	4.5	4	4	1	24	33
Nekia silty clay loam, 20 to 30 percent slopes	-	-	-	18	-	4.5	4	4	-	24	33
Nekia silty clay loam, 30 to 50 percent slopes	-	-	-	18	-	-	-	-	-	-	-
Nekia very stony silty clay loam, 30 to 50 percent slopes	-	-	-	-	-	-	-	-	-	24	-
Nekia stony silty clay loam, 2 to 12 percent slopes	-	-	-	18	-	4	3.5	3.5	-	34	30
Newberg fine sandy loam	11	4	8	18	5	5	3	4	1.2	28	30
Newberg silt loam	11	4	8	18	5	5	3	4	1.2	28	30
Salem gravelly silt loam	12	5	8	21	6	5	4	4	1	38	30
Salkum silty clay loam, 2 to 6 percent slopes	10	4	6	18	5	4.5	4	4	1	24	32
Salkum silty clay loam, 6 to 20 percent slopes	10	4	-	18	5	4.5	4	4	1	24	32

See footnotes at end of table.

TABLE 1.—*Predicted average acre yield of principal irrigated and dryland crops under a high level of management*—Con.

Soil	Irrigated crops					Dryland crops					
	Pole beans	Black-berries	Sweet corn	Pas-ture	Straw-berries	Alfalfa	Bent-grass seed	Sweet cherries	Fil-berts	Spring barley	Winter wheat
	Tons	*Tons*	*Tons*	*AUM*[1]	*Tons*	*Tons*	*Cwt.*	*Tons*	*Tons*	*Cwt.*	*Cwt.*
Salkum silty clay loam, basin, 0 to 6 percent slopes	11	5	8	21	5	6	4	4. 4	1	28	36
Santiam silt loam, 0 to 3 percent slopes[2]	11	5	8	21	5	6	4	4. 4	1	28	39
Santiam silt loam, 3 to 6 percent slopes	11	5	8	21	5	6	4	4. 4	1	28	39
Santiam silt loam, 6 to 15 percent slopes	11	5	-------	21	5	6	4	4. 4	1	28	39
Semiahmoo muck[2]	11	5	6	15	-------	-------	3	-------	-------	24	39
Sifton gravelly loam	10	4	5	12	5	3. 5	2. 5	-------	-------	24	24
Silverton silt loam, 2 to 12 percent slopes	10	4	6	18	5	4. 5	4	4	1	26	36
Silverton silt loam, 12 to 20 percent slopes	-------	-------	-------	18	5	4. 5	4	4	-------	26	36
Stayton silt loam, 0 to 7 percent slopes	-------	-------	-------	12	-------	-------	-------	-------	-------	-------	-------
Steiwer silt loam, 3 to 6 percent slopes	9	4	6	15	5	-------	2. 75	-------	-------	24	36
Steiwer silt loam, 6 to 20 percent slopes	-------	-------	-------	15	5	-------	2. 75	-------	-------	24	36
Steiwer and Chehulpum silt loams, 3 to 40 percent slopes	-------	-------	-------	12	-------	-------	-------	-------	-------	-------	-------
Terrace escarpments	-------	-------	-------	15	-------	-------	-------	-------	-------	-------	-------
Waldo silty clay loam[2]	10	4	6	18	-------	-------	4	-------	-------	24	30
Wapato silty clay loam[2]	10	4	6	18	-------	-------	4	-------	-------	24	36
Willamette silt loam, 0 to 3 percent slopes	12	5	8	21	6	6	4. 5	4. 4	1. 3	38	42
Willamette silt loam, 3 to 12 percent slopes	12	5	8	21	6	6	4. 5	4. 4	1. 3	38	42
Woodburn silt loam, 0 to 3 percent slopes[2]	11	5	8	21	5	6	4	4. 4	1. 3	38	42
Woodburn silt loam, 3 to 12 percent slopes	11	5	8	21	5	6	4	4. 4	1. 3	38	42
Woodburn silt loam, 12 to 20 percent slopes	11	5	-------	21	5	6	4	4. 4	1. 3	38	42

[1] AUM (animal-unit month) is a term used to express the carrying capacity of pasture. It is the number of animal units, 1,000 pounds of live weight, that can be grazed on an acre of pasture for a period of 30 days.

[2] Yields are for drained soil.

The soils and land types omitted from table 1 are mainly those in woodland and those that are steep, stony, or generally not used for farming. These units are—

Alluvial land.
Cumley silty clay loam, 2 to 20 percent slopes.
Henline very stony sandy loam, 6 to 30 percent slopes.
Henline very stony sandy loam, 30 to 55 percent slopes.
Henline very stony sandy loam, 55 to 80 percent slopes.
Hullt clay loam, 2 to 20 percent slopes.
Kinney cobbly loam, 2 to 20 percent slopes.
Kinney cobbly loam, 20 to 50 percent slopes.
Kinney cobbly loam, 50 to 70 percent slopes.
McCully clay loam, 2 to 30 percent slopes.
McCully clay loam, 50 to 70 percent slopes.
McCully very stony clay loam, 2 to 30 percent slopes.
Minniece silty clay loam, 0 to 8 percent slopes.
Nekia very stony silty clay loam, 2 to 30 percent slopes.
Stony rock land.
Whetstone stony loam, 3 to 25 percent slopes.
Whetstone stony loam, 25 to 55 percent slopes.
Whetstone stony loam, 55 to 75 percent slopes.
Witzel very stony silt loam, 3 to 40 percent slopes.

Predictions or estimates of yields are useful if the management is described through which such yields were obtained. In the pages that follow, management is described for each crop named in table 1 when that crop is grown on soils of a specified capability unit. All the soils in a capability unit require about the same management for a specified crop.

All requirements for plant nutrients are given for the elemental form; for example, the amount of the element phosphorus needed per acre is given. Recommendations for fertilizer and for use of amendments are given in the "Oregon State University Fertilizer Guides" for various crops. These fertilizer guides are revised as new information becomes available for a particular crop. The gross irrigation requirement is the total amount of water per acre needed annually by the plant, less the average effective precipitation. The irrigation requirement is calculated on the assumption that the irrigation system is 70 percent efficient.

MANAGEMENT OF IRRIGATED POLE BEANS

For the purpose of describing management of irrigated pole beans, soils of the survey area are divided into 10 groups. The management needed for soils in group 1 is described. The management needed for soils in groups 2 through 9 is similar to that described for group 1, except that additional practices may be needed or different specifications for fertilizer and lime may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils. Soils in group 10 are not suited to irrigated pole beans. Therefore, management for soils of that group is not given.

Group 1.—This group consists of soils of capability units I–1, IIs–1, and IIIs–1. For these soils a commonly used cropping system is pole beans grown year after year, with each crop followed by a green-manure crop, preferably a legume. Preparation of the seedbed consists of disking two or three times, harrowing one or two times, and then rolling the soil. The crop is planted in April, using a 1-row or a 2-row planter. Treated seed is planted at the rate of 25 to 30 pounds per acre. Weeds are controlled by applying a preemergence spray, by cultivating three or four times, and by hoeing by hand.

Fertilization consists of adding 100 to 150 pounds of nitrogen per acre in split applications and of applying 20 to 30 pounds of sulfur per acre by broadcasting it, putting it in the rows, or adding it to the irrigation water. Phosphorus and potassium are applied according to the needs indicated by the results of soil tests. Lime is applied at the rate of 1 to 3 tons per acre.

Stringing and training of the bean vines are necessary cultural practices, and fungicides and insecticides must be applied at suitable times. Sprinklers are used for applying irrigation water. Good irrigation management involves applying water at the proper time and rate, distributing the water evenly, and using moisture blocks. The gross irrigation requirement is about 22 inches of water per acre.

Harvesting is done by handpicking the beans five or six times. After the harvest is completed, the vines are cut, the temporary stakes are removed, and the soils are disked twice. Utilizing crop residue instead of removing it is a good conservation practice.

Group 2.—In this group are soils of capability units IIw–3, IIw–4, and IIw–6. Additional practices consist of growing a winter cover crop and of maintaining a permanent cover of plants in the annual overflow channels.

Group 3.—McBee silty clay loam, in capability unit IIw–5, is the only soil in this group. Additional practices consist of installing tile drains, of growing a winter cover crop, and of maintaining a permanent cover of plants in the annual overflow channels.

Group 4.—In this group are soils of capability unit IIw–1. Installing tile drains is the only additional practice needed.

Group 5.—In this group are soils of capability unit IIe–1. Additional practices consist of installing tile drains and of either farming across the slope, practicing rough tillage, and establishing grassed waterways or of growing a winter cover crop and establishing grassed waterways.

Group 6.—In this group are soils of capability units IIe–2 and IIe–3. Additional practices consist of either farming across the slope, practicing rough tillage, and establishing grassed waterways or of growing a winter cover crop and establishing grassed waterways. Lime is applied at the rate of 1 to 5 tons per acre.

Group 7.—In this group are soils of capability units IIIe–2, IIIe–3, IIIe–4, and IIIe–6. Additional practices consist of farming across the slope, growing a winter crop, and establishing grassed waterways. Lime is applied at the rate of 2 to 5 tons per acre.

Group 8.—In this group are soils of capability units IIw–2, IIIw–1, IIIw–2, IIIw–3, and IVw–1. Additional practices consist of installing clay tile drains or box drains.

Group 9.—In this group are soils of capability units IIIe–1 and IIIe–5. Additional practices consist of installing tile drains and of farming across the slope, growing a winter cover crop, and establishing grassed waterways.

Group 10.—In this group are soils of capability units IVe–1, IVe–2, IVw–1, IVw–2, IVw–3, VIe–1, VIe–2, VIs–1, VIIe–1, VIIw–1, VIIs–1, and VIIs–1. These soils are too stony or too steep for cultivation, or they are otherwise unsuited to pole beans.

Management of Irrigated Blackberries

For the purpose of describing the management of irrigated blackberries, soils of the survey area are divided into 10 groups. The management needed for soils in group 1 is described. The management needed for soils in groups 2 through 9 is similar to that described for group 1, except that additional practices may be needed or different specifications for fertilizer and lime may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils. Soils in group 10 are not suited to irrigated blackberries. Therefore, management for soils of that group is not given.

Group 1.—This group consists of soils of capability units I–1, IIs–1, and IIIs–1. For these soils a commonly used cropping system consists of growing blackberries continuously for at least 10 years and of growing an annual legume between the rows as a green-manure crop. Preparation of the seedbed consists of diskplowing three times, harrowing three times, and fumigating the soil. Before the crop is planted, a soil insecticide is applied to control wireworms and root weevils.

Fertilization consists of applying 80 to 100 pounds per acre of nitrogen and 2 or 3 pounds of boron. Phosphorus, potassium, lime, and magnesium are applied according to needs indicated by the results of soil tests.

Planting is done by hand. The plants are placed in rows spaced 10 feet apart, with 3 to 5 feet left between the hills. A good variety for planting is Thornless Evergreen. Weeds are controlled by cultivating three or four times, hoeing by hand once, using a herbicide in fall, spraying in spring, and then spot spraying. Cultural practices consist of pruning, clipping, and training the blackberry vines and of spraying with an insecticide two or three times.

Sprinklers are used for applying irrigation water. Good irrigation management consists of applying water at the proper time and rate, distributing the water evenly, and using moisture blocks. The gross irrigation requirement is about 16 inches of water per acre.

Harvesting is done mainly by machine, but some harvesting is done by hand. Subsoiling is done once to a depth of 18 to 20 inches down the center of the row.

Group 2.—In this group are soils of capability units IIw–3, IIw–4, and IIw–6. Additional practices consist of growing a winter cover crop and of maintaining a permanent cover of plants in the annual overflow channels.

Group 3.—In this group are soils of capability unit IIw–1. Installing tile drains is the only additional practice needed.

Group 4.—McBee silty clay loam, in capability unit IIw–5, is the only soil in this group. Additional practices consist of growing a winter cover crop, maintaining a permanent cover of plants in the annual overflow channels, and installing tile drains.

Group 5.—In this group are soils of capability units IIe–2 and IIe–3. Additional practices consist of either farming across the slope, practicing rough tillage, and establishing grassed waterways or of growing a winter cover crop and establishing grassed waterways.

Group 6.—In this group are soils of capability units IIIe–2, IIIe–3, IIIe–4, and IIIe–6. Additional practices consist of field stripcropping, of establishing grassed waterways, and of growing a winter cover crop or practicing rough tillage.

Group 7.—In this group are soils of capability units IIIe–1 and IIIe–5. Additional practices consist of field stripcropping, establishing grassed waterways, growing a winter crop, and installing clay tile drains.

Group 8.—In this group are soils of capability units IIw–2, IIIw–1, IIIw–2, IIIw–3, and IVw–1. Additional practices consist of installing clay tile drains or box drains.

Group 9.—In this group are soils of capability unit IIe–1. Additional practices consist of installing tile drains and of either farming across the slope, establishing grassed waterways, and practicing rough tillage or growing a winter cover crop and establishing grassed waterways.

Group 10.—In this group are soils of capability units IVe–1, IVe–2, IVw–2, IVw–3, VIe–1, VIe–2, VIw–1, VIs–1, VIIe–1, VIIw–1, VIIs–1, and VIIIs–1. These soils are too stony or too steep for cultivation, or they are otherwise unsuited to irrigated blackberries.

Management of Irrigated Sweet Corn

For the purpose of describing management of irrigated sweet corn, soils of the survey area are divided into 10 groups. The management needed for soils in group 1 is described. The management needed for soils in groups 2 through 9 is similar to that described for group 1, except that additional practices may be needed or different specifications for fertilizer and lime may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils. Soils in group 10 are not suited to irrigated sweet corn. Therefore, management for soils of that group is not given.

Group 1.—This group consists of soils of capability units I–1, IIs–1, and IIIs–1. For these soils a commonly used cropping system is 1 year of sweet corn followed by a green-manure crop, and 1 year of pole beans followed by crimson clover grown as a green-manure crop. Preparation of the seedbed consists of disking three or four times, harrowing three or four times, and using a soil insecticide before planting the crop. The crop is planted at the rate of 8 to 10 pounds of seed per acre, using a corn planter. Golden Cross Bantam and FM–Cross are varieties commonly grown. Weeds are controlled by using a preemergence spray and by cultivating one or two times, as needed.

Fertilization consists of adding 100 to 125 pounds of nitrogen per acre in split applications and of applying 15 to 20 pounds of sulfur per acre. Phosphorus and potassium are applied according to the needs indicated by the results of soil tests. For the pole beans included in the cropping system, lime is applied at the rate of 1 to 3 tons per acre. Where necessary, topping with an insecticide is included in the cultural practices. Sprinklers are used for applying irrigation water. The gross irrigation requirement is about 19 inches of water per acre.

Harvesting is done by machine. Utilizing all crop residue is a good conservation practice.

Group 2.—In this group are soils of capability units IIw–3, IIw–4, and IIw–6. Additional practices consist of growing a winter cover crop or of leaving cornstalks standing in the field and of maintaining a permanent cover of plants in the overflow channels.

Group 3.—In this group are soils of capability unit IIe–1. Additional practices consist of installing tile drains and of either farming across the slope, practicing rough tillage, and establishing grassed waterways or of growing a winter crop and establishing grassed waterways.

Group 4.—McBee silty clay loam, in capability unit IIw–5, is the only soil in this group. Additional practices consist of installing tile drains, of growing a winter cover crop or utilizing crop residue to protect the soil, and of maintaining a permanent cover of plants in the annual overflow channels.

Group 5.—In this group are soils of capability unit IIw–1. Installing tile drainage is the only additional practice needed.

Group 6.—In this group are soils of capability units IIe–2 and IIe–3. Additional practices consist of either farming across the slope, practicing rough tillage, and establishing grassed waterways or of growing a winter cover crop and establishing grassed waterways. Lime is applied at the rate of 2 to 5 tons per acre for the legume included in the cropping system.

Group 7.—In this group are soils of capability units IIIe–1 and IIIe–5. Additional practices consist of installing tile drainage, farming across the slope, growing a winter cover crop, and establishing grassed waterways.

Group 8.—In this group are soils of capability units IIIe–3, IIIe–4, and IIe–6. Additional practices consist of farming across the slope, growing a winter cover crop, and establishing grassed waterways.

Group 9.—In this group are soils of capability units IIw–2, IIIw–1, IIIw–2, IIIw–3, IVw–1, and IVw–2. Additional practices consist of installing clay tile drains, box drains, or surface drains.

Group 10.—In this group are soils of capability units IIIe–2, IVe–1, IVe–2, IVw–3, VIe–1, VIe–2, VIw–1, VIs–1, VIIe–1, VIIw–1, VIIs–1, and VIIIs–1. These soils are too stony or too steep for cultivation, or they are otherwise unsuited to sweet corn.

Management of Irrigated Pasture

For the purpose of describing management of irrigated pasture, soils of the survey area are divided into 12 groups. The management needed for soils in group 1 is described. The management needed for soils in groups 2 through 11 is similar to that described for group 1, except that additional practices may be needed or different specifications for fertilizer and lime may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils. Soils in group 12 are not suited to irrigated pasture. Therefore, management for soils of that group is not given.

Group 1.—This group consists of soils of capability units I–1, IIs–1, and IIIs–1. For these soils a suitable cropping system is 6 years of pasture and 2 years of small grain. Where a pasture is to be established, preparation of the seedbed consists of diskplowing two to five times, harrowing two to five times, and cultipacking. Fertilization needed to establish the stand consists of applying 30 pounds per acre of nitrogen, 20 to 30 pounds per acre of sulfur, and 2 to 3 pounds per acre of boron. Phosphorus and potassium are applied according to the needs indicated by the results of soil tests.

After the stand is established, annual applications of 40 pounds of nitrogen per acre and 20 to 30 pounds of sulfur per acre are made late in February or early in March. An additional 30 to 40 pounds per acre of nitrogen is added in split applications in May and August. The amounts of phosphorus, potassium, and boron to apply are determined by testing the soils. Lime is applied at the rate of 1 to 3 tons per acre.

Suitable mixtures for seeding are 10 pounds of Latar orchardgrass and 2 pounds of New Zealand white clover; 12 pounds of alta fescue and 2 pounds of New Zealand white clover; or 10 pounds of Latar orchardgrass and 5 pounds of DuPuit alfalfa. Suitable dates for planting are April 15 to May 15 and August 15 to September 15.

Sprinklers are used for applying irrigation water. Irrigation involves applying water at the proper time and rate, distributing the water evenly, and using moisture blocks. The gross irrigation requirement during the period June 1 to September 20 is about 22 inches of water per acre.

Pastures are grazed from April through October. Good pasture management includes dividing the fields so that each field can be grazed 1 day and then rested, or so that the forage can be chopped green and fed in a dry lot. In areas under irrigation, 24 to 35 days is allowed for regrowth of the plants before grazing is again allowed. Weed control consists of clipping three or four times each season and of using a herbicide for spot spraying. Manure is spread three or four times each season, using a spiketooth harrow.

Group 2.—In this group are soils of capability units IIw–3, IIw–4, IIw–6, and IVw–3. Additional practice consists of maintaining a permanent cover of plants in the annual overflow channels. Suitable dates for planting in spring are May 15 to June 15.

Group 3.—In this group are soils of capability units IIe–2 and IIe–3. Additional practices consist of farming across the slope and of establishing grassed waterways.

Group 4.—In this group are soils of capability units IIIe–2, IIIe–4, IIIe–6, and IVe–1. Additional practices consist of farming across the slope or on the contour and of establishing grassed waterways. Seeding is done in spring between April 15 and May 15. Lime is applied at the rate of 2 to 5 tons per acre.

Group 5.—In this group are soils of capability units IIIw–3, IVw–1, and IVw–2. Additional practices consist of installing tile or box drains and of grading the soils to improve drainage. A suitable seeding mixture is 6 pounds of meadow foxtail, 4 pounds of Drumond timothy, 2 pounds of New Zealand white clover, and 2 pounds of big trefoil.

Group 6.—McBee silty clay loam, in capability unit IIw–5, is the only soil in this group. Additional practices consist of maintaining a permanent cover of plants in the annual overflow channels and of installing tile drains. Suitable dates for planting in spring are May 15 to June 15.

Group 7.—In this group are soils of capability unit IIe–1. Additional practices consist of farming across the slope, keeping a cover on the soils in winter, establishing grassed waterways, and installing interceptor ditches and random and grid drainage.

Group 8.—In this group are soils of capability units IIIe–1 and IIIe–5. Additional practices consist of farming across the slope, keeping a cover of plants on the soils in winter, establishing grassed waterways, and installing interceptor ditches and random tile drains. Lime is applied at a rate of 2 to 3 tons per acre.

Group 9.—In this group are soils of capability units IIw–1, IIw–2, and IIIw–1. Installing tile drains is the only additional practice needed.

Group 10.—In this group are soils of capability units IIIe–3, IVe–2, VIe–1, and VIe–2. Additional practices consist of farming on the contour and establishing grassed waterways. Lime is applied at a rate of 2 to 4 tons per acre. Suitable seeding mixtures are 10 pounds of orchardgrass and 2 pounds of New Zealand white clover, or 12 pounds of alta fescue and 2 pounds of New Zealand white clover. Seeding is done in spring. Suitable seeding dates are April 15 to May 15.

Group 11.—In this group are soils of capability unit IIIw–2. Installing tile drainage is the only additional practice needed. Suitable seeding mixtures are 10 pounds of Latar orchardgrass and 2 pounds of New Zealand white clover or 12 pound of alta fescue and 2 pounds of New Zealand white clover.

Group 12.—In this group are soils of capability units VIw–1, VIs–1, VIIe–1, VIIw–1, VIIs–1, and VIIIs–1. These soils are too stony, too shallow, or too steep for cultivation, or they are otherwise unsuitable for pasture.

Management of Irrigated Strawberries

For the purpose of describing the management of irrigated strawberries, soils of the survey area are divided into nine groups. The management needed for soils in group 1 is described. The management needed for soils in groups 2 through 8 is similar to that described for group 1, except that additional practices may be needed or different specifications for fertilizer and lime may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils. Soils in group 9 are not suited to irrigated strawberries. Therefore, management for soils of that group is not given.

Group 1.—This group consists of soils of capability units I–1, IIs–1, and IIIs–1. For these soils a commonly used cropping system is 3 or 4 years of strawberries, 4 or 5 years of grass or of grasses and legumes, and 1 year of a spring small grain or a row crop. Preparation of the seedbed consists of diskplowing two or three times, harrowing two or three times, chiseling in fall, and grading the soils, where needed.

Fertilizer requirements for establishing the crop consist of applying 60 to 90 pounds per acre of nitrogen and 40 to 60 pounds per acre of potassium. A sidedressing of 20 to 30 pounds per acre of nitrogen is applied in August. After the plants are established, the amounts of fertilizer needed annually are 60 to 90 pounds per acre of nitrogen, 60 to 80 pounds per acre of phosphorus, 70 to 90 pounds per acre of potassium, 15 to 20 pounds per acre of sulfur, and 1 pound per acre of boron, applied as a spray. In cold, wet springs, 30 pounds of nitrogen per acre and 20 pounds per acre of phosphorus are applied. Soil tests are needed to determine the specific requirements for boron. Lime is applied at a rate of 1 to 2 tons per acre for the legumes included in the cropping system.

Strawberries are planted by machine in spring. A good variety for planting is certified Northwest. The plants are spaced 18 to 22 inches apart, and 36 to 42 inches is left between the rows. The plants are cultipacked after they are set out.

Weeds are controlled by applying chemicals. The beds are also cultivated two to four times and are hoed by hand. Runners are controlled and tops are mowed as an aid in sanitation and in harvesting. Herbicides are applied in fall, and soil insecticides are applied to control root weevil. The plants are sprayed five or six times during spring and summer to control insects and diseases.

Sprinklers are used for applying irrigation water. Good irrigation management consists of applying water at the proper time and rate, of distributing the water evenly, and of using moisture blocks. Maintaining the content of moisture in the soils at 75 percent of field capacity improves both the quantity and the quality of the crop. The gross irrigation water requirement is about 16 inches of water per acre.

Harvesting is done by hand.

Group 2.—In this group are soils of capability units IIw–3, IIw–4, and IIw–6. Additional practices consist of growing a winter cover crop and maintaining a permanent cover of plants in the annual overflow channels.

Group 3.—In this group are soils of capability units IIe–2 and IIe–3. Additional practices consist of either farming across the slope, practicing rough tillage, and establishing grassed waterways or of growing a winter cover crop and establishing grassed waterways.

Group 4.—In this group are soils of capability units IIIe–2, IIIe–3, IIIe–4, IIIe–6, and IVe–2. Additional practices consist of practicing field stripcropping, establishing grassed waterways, and growing a winter cover crop or practicing rough tillage. Lime is applied at the rate of 2 to 5 tons per acre for the legume included in the cropping system.

Group 5.—In this group are soils of capability units IIw–1, IIw–2, and IIIw–1. Installing clay tile drains is the only additional practice needed.

Group 6.—In this group are soils of capability unit IIe–1. Additional practices consist of installing clay tile drains and of either farming across the slope, establishing grassed waterways, and practicing rough tillage or of growing a winter cover crop and establishing grassed waterways.

Group 7.—McBee silty clay loam, in capability unit IIw–5, is the only soil in this capability unit. Additional practices consist of growing a winter cover crop, maintaining a permanent cover of plants in the annual overflow channels, and establishing tile drainage.

Group 8.—In this group are soils of capability units IIIe–1 and IIIe–5. Additional practices consist of farming across the slope, establishing grassed waterways, growing a winter cover crop, and installing clay tile drains.

Group 9.—This group consists of soils of capability units IIIw–2, IIIw–3, IVe–1, IVw–1, IVw–2, IVw–3, VIe–1, VIe–2, VIw–1, VIs–1, VIIe–1, VIIw–1, VIIs–1, and VIIIs–1. These soils are poorly drained; are too droughty, too stony, or too steep for cultivation; or are otherwise unsuited to strawberries.

Management of Dryland Alfalfa

For the purpose of describing management of dryland alfalfa, soils of the survey area are divided into eight groups. Management needed for soils in group 1 is described. The management needed for soils in groups 2 through 7 is similar to that described for group 1, except that additional practices may be needed or different specifications for fertilizer and lime may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils. Soils in group 8 are not suited to dryland alfalfa. Therefore, management for soils of that group is not given.

Group 1.—This group consists of soils of capability units I–1, IIs–1, and IIIs–1. For these soils a commonly used cropping system is 4 or 5 years of alfalfa and 2 years of winter wheat. The second year of winter wheat is followed by crimson clover that is plowed under in fall as a green-manure crop. Then, alfalfa is again planted in spring. Preparation of the seedbed consists of plowing and harrowing two to five times and then cultipacking. DuPuits, Flemish type, is a suitable variety of planting. The seed is innoculated and is then drilled immediately at a rate of 15 pounds per acre. Suitable seeding dates are April 15 to May 15 or August 15 to September 15.

Fertilization needed to help establish the stand consists of applying boron, phosphorus, and potassium according to the needs indicated by the results of soil tests. Lime is also applied according to the needs indicated by the results of soil tests, and sulfur is applied at a rate of 20 to 40 pounds per acre. Each year thereafter, sulfur is applied at the rate of 20 to 30 pounds per acre and phosphorus, potassium, and boron are applied according to the needs indicated by the results of soil tests.

Clipping and herbicides are used to control weeds during the year the crop is established. After the stand is established, herbicides are used in October.

In some years harvesting consists of mowing, conditioning, raking, and baling the hay. In others the first cutting is used for silage and the second and third cuttings are used for hay.

Group 2.—In this group are soils of capability units IIe–2, IIe–3, IIIe–2, IIIe–4, and IIIe–6. Additional practices consist of farming across the slope and establishing grassed waterways. A small grain is grown as a winter cover crop for fall-seeded alfalfa. Lime is applied at a rate of 2 to 5 tons per acre.

Group 3.—In this group are soils of capability units IIe–1 and IIIe–1. Additional practices consist of installing tile drainage, of farming across the slope and establishing grassed waterways, and of growing a small grain as a winter cover crop for fall-seeded alfalfa.

Group 4.—In this group are soils of capability unit IVe–1. Additional practices consist of either field stripcropping and establishing grassed waterways or of farming on the contour and establishing grassed waterways. A small grain is grown as a winter cover crop for fall-seeded alfalfa. Lime is applied at a rate of 2 to 5 tons per acre.

Group 5.—In this group are soils of capability units IIw–1, IIw–2, IIIe–5, and IIIw–1. Installing clay tile drains is the only additional practice needed.

Group 6.—In this group are soils of capability units IIw–3, IIw–4, and IIw–6. Additional practices consist of maintaining a permanent cover of plants in the overflow channels. The crop is planted in spring between May 15 and June 15.

Group 7.—McBee silty clay loam, in capability unit IIw–5, is the only soil in this group. Additional practices consist of maintaining a permanent cover of plants in the overflow channels, of installing tile drainage, and of planting the crop in spring between May 15 and June 15.

Group 8.—In this group are soils of capability units IIIe–3, IIIw–2, IIIw–3, IVe–2, IVw–1, IVw–2, IVw–3, VIe–1, VIe–2, VIw–1, VIs–1, VIIe–1, VIIw–1, VIIs–1, and VIIIs–1. These soils are poorly drained or excessively drained, are too shallow or too steep for cultivation, or are otherwise unsuited to alfalfa.

Management of Dryland Bentgrass for Seed

For the purpose of describing management of dryland bentgrass for seed, soils of the survey area are divided into six groups. Management needed for soils in group 1 is described. The management needed for soils in groups 2 through 5 is similar to that described for group 1, except that additional practices may be needed or different specifications for fertilizer and lime may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils. Soils in group 6 are not suited to dryland bentgrass grown for seed. Therefore, management for soils of that group is not given.

Group 1.—This group consists of soils of capability units I–1, IIw–3, IIw–4, IIw–6, IIs–1, and IIIs–1. A well-prepared seedbed is essential when the stand of grass is established. After the stand is established, it can be renovated by plowing and working down lightly every 3 or 4 years. Planting is done either in spring or in fall. A good variety for planting is Highland.

Fertilization consists of applying nitrogen in fall at a rate of 20 to 30 pounds per acre and of applying 50 to 70 pounds of nitrogen per acre in spring. Phosphorus and potassium are applied according to the needs indicated by the results of soil tests.

Weeds are controlled by applying a herbicide in fall and spring. Nematodes are controlled by burning in fall. A combine is used for harvesting this crop.

Group 2.—In this group are soils of capability units IIw–1, IIw–2, IIw–5, IIIw–1, IIIw–2, IVw–1, and IVw–2. Installing tile drainage is the only additional practice needed.

Group 3.—In this group are soils of capability units IIe–1 and IIIe–5. Additional practices consist of installing tile drains and of growing a small grain as a winter cover crop for fall-seeded grass.

Group 4.—In this group are soils of capability units IIe–2, IIe–3, IIIe–1, IIIe–2, IIIe–3, IIIe–4, IIIe–6, IVe–1, and IVe–2. Growing a small grain as a winter cover for fall-seeded grass is the only additional practice needed.

Group 5.—Semiahmoo muck, in capability unit IIIw–3, is the only soil in this group. Installing box drains is the only additional practice needed.

Group 6.—In this group are soils of capability units IVw–3, VIe–1, VIe–2, VIw–1, VIs–1, VIIe–1, VIIw–1, VIIs–1, and VIIIs–1. These soils are too stony or too steep for cultivation, or they are otherwise unsuitable for growing bentgrass.

Management of Dryland Sweet Cherries

For the purpose of describing management of dryland sweet cherries, soils of the survey area are divided into eight groups. Management needed for soils in group 1 is described. The management needed for soils in groups 2 through 7 is similar to that described for group 1, except that additional practices may be needed or different specifications for fertilizer and lime may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils. Soils in group 8 are not suited to dryland sweet cherries. Therefore, management for soils of that group is not given.

Group 1.—In this group are soils of capability units I–1 and IIs–1. On these soils 48 trees are planted per acre, which allows for a spacing of about 30 by 30 feet for each tree when the trees are 35 years of age or older. A variety commonly grown is Royal Ann. Every third tree in each row should be of a proper variety for pollinizing the crop. A suitable mixture for seeding as a green-manure crop is 60 pounds of a small grain plus 40 pounds of common vetch or 10 pounds of crimson clover.

Fertilizer is applied annually at a rate of 2 pounds of nitrogen per tree, and boron is added as needed. Lime is applied at a rate of 1 to 3 tons per acre for the legume grown as a green-manure crop.

Cultural practices consist of pruning.

Group 2.—In this group are soils of capability units IIw–3, IIw–4, and IIw–6. Additional practices consist of protecting the soils with a winter cover crop and of maintaining a permanent cover of plants in the annual overflow channels.

Group 3.—In this group are soils of capability units IIe–2, IIe–3, IIIe–2, IIIe–4, and IIIe–6. Additional practices consist of either farming across the slope, establishing grassed waterways, and practicing rough tillage or of protecting the soils with a winter cover crop and establishing grassed waterways. Lime is applied at a rate of 2 to 4 tons per acre for the legume grown as green manure.

Group 4.—McBee silty clay loam, in capability unit IIw–5, is the only soil in this group. Additional practices consist of installing tile drainage, of protecting the soils with a winter cover crop, and of maintaining a permanent cover of plants in the annual overflow channels.

Group 5.—In this group are soils of capability units IIe–1 and IIIe–1. Additional practices consist of installing tile drainage and of either farming across the slope, establishing grassed waterways, and practicing rough tillage or of protecting the soils with a winter cover crop and establishing grassed waterways.

Group 6.—In this group are soils of capability unit IVe–1. Additional practices consist of farming on the contour, of establishing grassed waterways, and of protecting the soils with a winter cover crop. Lime is applied at a rate of 2 to 4 tons per acre.

Group 7.—In this group are soils of capability units IIw–1, IIw–2, and IIIe–5. Installing clay tile drains is the only additional practice needed.

Group 8.—In this group are soils of capability units IIIe–3, IIIw–1, IIIw–2, IIIw–3, IIIs–1, IVe–2, IVw–1, IVw–2, IVw–3, VIe–1, VIe–2, VIw–1, VIs–1, VIIe–1, VIIw–1, VIIs–1, and VIIIs–1. These soils are not suitable for growing cherries.

Management of Dryland Filberts

For the purpose of describing management of dryland filberts, soils of the survey area are divided into eight groups. Management needed for soils in group 1 is described. The management needed for soils in groups 2 through 7 is similar to that described for group 1, except that additional practices may be needed or different specifications for fertilizer and lime may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils. Soils in group 8 are not suited to dryland filberts. Therefore, management for soils of that group is not given.

Group 1.—This group consists of soils of capability units I–1 and IIs–1. On these soils 75 trees are planted per acre, which allows for a spacing of about 20 by 20 feet for each tree when the trees are 15 years of age or older. Barcelona or newer varieties are commonly grown.

From 100 to 125 pounds of nitrogen is applied between February 15 and March 15. Other fertilizer requirements can be learned by consulting the county horticulturist. Lime is applied at a rate of 1 to 3 tons per acre if legumes are grown as a green-manure crop.

Weeds are controlled by summer fallowing and by spot spraying. Other cultural practices consist of cultivating to a depth of less than 3 or 4 inches, of using a chemical to control the growth of suckers, and of systematically pruning every fifth row each year until the entire orchard is pruned over a 5-year period. Half of the material pruned is wood. Utilizing all residue of crops grown between the trees is a good conservation practice.

Group 2.—In this group are soils of capability units IIw–3, IIw–4, and IIw–6. Additional practices consist of protecting the soils with a winter cover crop or with crop residue and maintaining a permanent cover of plants in the annual overflow channels.

Group 3.—In this group are soils of capability unit IIe–1. Additional practices consist of installing tile drainage and of either farming across the slope, establishing grassed waterways, and practicing rough tillage or of growing a winter crop between the trees and establishing grassed waterways.

Group 4.—McBee silty clay loam, in capability unit IIw–5, is the only soil in this capability unit. Additional practices consist of growing a winter cover crop between the trees, of maintaining a permanent cover of plants in the annual overflow channels, and of establishing tile drainage.

Group 5.—In this group are soils of capability units IIe–2, IIe–3, IIIe–2, and IIIe–6. Additional practices consist of applying lime at a rate of 2 to 4 tons per acre if a legume is grown as a cover crop and of either farming across the slope, establishing grassed waterways, and practicing rough tillage or of growing a winter cover crop and establishing grassed waterways.

Group 6.—In this group are soils of capability units IIw–1 and IIw–2. Installing clay tile drains is the only additional practice needed.

Group 7.—In this group are soils of capability units IIIe–1 and IIIe–5. Additional practices consist of installing clay tile drains, farming across the slope, growing a winter cover crop, and establishing grassed waterways.

Group 8.—In this group are soils of capability units IIIe–3, IIIe–4, IIIw–1, IIIw–2, IIIw–3, IIIs–1, IVe–1, IVe–2, IVw–1, IVw–2, IVw–3, VIe–1, VIe–2, VIw–1, VIs–1, VIIe–1, VIIw–1, VIIs–1, and VIIIs–1. These soils are poorly drained or excessively drained; are too shallow, stony, or steep to be cultivated; or are otherwise not suitable for growing filberts.

Management of Dryland Spring Barley

For the purpose of describing management of dryland spring barley, soils of the survey area are divided into 12 groups. Management needed for soils in group 1 is described. The management needed for soils in groups 2 through 11 is similar to that described for group 1, except that additional practices may be needed or different specifications for fertilizer and lime may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils. Soils in group 12 are not suited to dryland spring barley. Therefore, management for soils of that group is not given.

Group 1.—This group consists of soils of capability units I–1, IIs–1, and IIIs–1. For these soils a suitable cropping system is 2 years of barley and 4 years of grasses and legumes. Preparation of the seedbed consists of diskplowing two or three times and of harrowing two or three times. Hannchen is a good variety for seeding. The seed is drilled at a rate of 100 pounds per acre.

Fertilization consists of applying 40 pounds per acre of nitrogen, 40 pounds of phosphorus, and 40 pounds of potassium, banded 1 inch from the seed. Lime is applied at the rate of about 1 to 3 tons per acre, and sulfur is applied at the rate of 5 to 10 pounds per acre for the legumes included in the cropping system.

A herbicide is applied in spring to control broadleaf weeds and annual grasses. Harvesting is done by combine. Utilizing crop residue instead of removing it is a good conservation practice.

Group 2.—In this group are soils of capability units IIw–3, IIw–4, and IIw–6. Additional practices consist of growing a winter cover crop and of maintaining a permanent cover of plants in annual overflow channels.

Group 3.—In this group are soils of capability units IIw–1, IIw–2, and IIIw–1. Installing tile drains is the only additional practice needed.

Group 4.—In this group are soils of capability unit IIe–1. Additional practices consist of installing tile drains and of either farming across the slope, establishing grassed waterways, and practicing rough tillage or of growing a winter cover crop and establishing grassed waterways.

Group 5.—McBee silty clay loam, in capability unit IIw–5, is the only soil in this group. Additional practices consist of providing cover for this soil in winter, of maintaining a permanent cover of plants in the annual overflow channels, and of installing tile drains.

Group 6.—In this group are soils of capability units IIe–2 and IIe–3. Additional practices consist of farming across the slope, establishing grassed waterways, and practicing rough tillage.

Group 7.—In this group are soils of capability units IIIe–2, IIIe–3, IIIe–4, and IIIe–6. Additional practices consist of farming across the slope, establishing grassed waterways, and providing cover for the soils in winter. Lime is applied at the rate of 2 to 5 tons per acre for the legumes included in the cropping system.

Group 8.—In this group are soils of capability units IVe–1 and IVe–2. Additional practices consist of either practicing field stripcropping, establishing grassed waterways, and providing cover for the soils in winter or practicing rough tillage or of farming on the contour, establishing grassed waterways, and providing cover for the soils in winter.

Group 9.—In this group are soils of capability units IIIw–2, IIIw–3, and IVw–1. Additional practices consist of installing clay tile drains, box tile drains, or open ditches.

Group 10.—Bashaw clay, in capability unit IVw–2, is the only soil in this group. Providing surface drainage is the only additional practice needed.

Group 11.—In this group are soils of capability units IIIe–1 and IIIe–5. Additional practices consist of installing clay tile drains or open ditches, and of either farming across the slope, establishing grassed waterways, and practicing rough tillage or of growing a winter cover crop and establishing grassed waterways.

Group 12.—In this group are soils of capability units IVw–3, VIe–1, VIe–2, VIw–1, VIs–1, VIIe–1, VIIw–1, VIIs–1, and VIIIs–1. These soils are too shallow, too stony, or too steep for cultivation, or they are otherwise unsuitable for growing spring barley.

Management of Dryland Winter Wheat

For the purpose of describing management of dryland winter wheat, soils of the survey area are divided into 10 groups. Management needed for soils in group 1 is described. The management needed for soils in groups 2 through 9 is similar to that described for group 1, except that additional practices may be needed or different specifications for fertilizer and lime may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils. Soils in group 10 are not suited to dryland winter wheat. Therefore, management for soils of that group is not given.

Group 1.—This group consists of soils of capability units I–1, IIs–1, and IIIs–1. For these soils a commonly used cropping system is 2 years of wheat and 2 years of red clover. Preparation of the seedbed consists of disk-plowing two or three times and of harrowing two or three times. A good variety for planting is Dru Champ. The crop is planted at a rate of 100 pounds of seed per acre.

Fertilization consists of applying 20 pounds of nitrogen per acre in fall, and 40 to 50 pounds per acre in March. Phosphorus and potassium are applied in fall according to needs indicated by the results of soil tests. When soil reaction drops below 5.5, lime is applied at the rate of 2 or 3 tons per acre for the legume included in the cropping system. About 10 to 20 pounds per acre of sulfur is generally needed.

The type of herbicide to apply for weed control is determined by the kind and degree of infestation. Applying a herbicide in fall is desirable for controlling annual grasses. An application in spring is desirable for controlling broad-leaved weeds.

Harvesting is done by combine. A good conservation practice is utilization of crop residue.

Group 2.—In this group are soils of capability units IIw–3, IIw–4, and IIw–6. Maintaining a permanent cover of plants in the annual overflow channels is the only additional practice needed.

Group 3.—In this group are soils in capability units IIw–1, IIw–2, and IIIw–1. Installing tile drainage is the only additional practice needed.

Group 4.—McBee silty clay loam, in capability unit IIw–5, is the only soil in this group. Additional practices consist of installing tile drainage and of maintaining a permanent cover of plants in the annual overflow channels.

Group 5.—In this group are soils of capability unit IIe–1. Additional practices consist of installing tile drainage, farming across the slope, establishing grassed waterways, and practicing rough tillage.

Group 6.—In this group are soils of capability units IIIe–1 and IIIe–5. Additional practices consist of installing tile drains or open-ditch drains, farming across the slope, establishing grassed waterways, and practicing rough tillage.

Group 7.—In this group are soils of capability units IIe–2, IIe–3, IIIe–2, IIIe–3, IIIe–4, and IIIe–6. Additional practices consist of farming across the slope and establishing grassed waterways. Lime is applied at the rate of 2 to 5 tons per acre for the legume included in the cropping system.

Group 8.—In this group are soils of capability units IVe–1 and IVe–2. Additional practices consist of either field stripcropping and establishing grassed waterways or of farming on the contour and establishing grassed waterways. Lime is applied at the rate of 2 to 5 tons per acre for the legume included in the cropping system.

Group 9.—In this group are soils of capability units IIIw–2, IIIw–3, and IVw–1. Installing clay tile drains or box drains is the only additional practice needed.

Group 10.—In this group are soils of capability units IVw–2, IVw–3, VIe–1, VIe–2, VIw–1, VIs–1, VIIe–1, VIIs–1, VIIw–1, and VIIIs–1. These soils are poorly drained, excessively drained, or too shallow or too steep for cultivation, or they are otherwise unsuited to winter wheat.

Use of the Soils as Woodland [3]

This section contains interpretations for soils of the survey area used and managed as woodland. Subjects that are discussed are occurrence of native species of trees, the vegetation in the understory, the site quality for Douglas-fir, natural competition from undesirable plants, mortality of tree seedlings, limitations to the use of heavy equipment, and hazards of erosion and windthrow. Comments are also included on the harvest of special products and on management of the soils for producing these products.

Travelers who crossed the Cascade Mountains to the valley of the Willamette River in 1824 reported that their route was over plains covered by ferns that were nearly 7 feet tall. They also traveled through forests composed of pine, oak, and ash, and of Douglas-fir of extraordinary size. The broad floor of the valley supported a dense forest of Douglas-fir, western redcedar, and hardwoods. The composition at any particular place depended on the natural drainage and on the quality of the soils. Openings in the forest had been made by recurring fires set to destroy the vegetation. Later, settlers burned cutover areas and areas where fern grew in the belief that they could keep such areas open for use as pasture. The fires were set early in spring.

Trees on the low foothills were Douglas-fir and Oregon white oak. Above an elevation of 1,000 feet, the composition of the forest changed to Douglas-fir mixed with varying amounts of alder, maple, and western hemlock. Above an elevation of 2,500 feet, western hemlock, noble fir, and silver fir were the main forest trees.

In 1960, forests in the survey area accounted for 124,680 acres. The forests were mostly at elevations above 1,000 feet in an area that coincides with that in which the soils were mapped with medium intensity of detail. Nearly all of the original forest trees had been harvested, and only stands of second-growth trees were available for site studies. Many of the second-growth trees, however, had grown to merchantable size, and they, in turn, had been harvested. Consequently, study plots for determining site quality were located only on soil mapping units where a

[3] Walter M. Fergerson, woodland specialist, Soil Conservation Service, assisted in preparing this section.

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suitable stand of trees was available for measuring the heights of the trees and for evaluating other interpretative information about the forests.

The heights of an equal number of dominant and codominant trees were measured. The heights of at least four trees were measured on each of 65 plots studied. The soils in each plot were identified and were described. Potential soil productivity was determined only for Douglas-fir, because that is the predominant tree in the survey area. Also, it is the only species in the survey area for which published yield tables are available (*7*).

SITE CLASS.—The relative measure of a soil's wood-producing ability can be expressed by site classes. Under this system the highest producing soil is designated as in site class 1, and the lowest, as in site class 5. Soils in classes 2, 3, and 4 have intermediate wood-producing capacity. The grouping of soils into site classes is based on the average total height of the dominant and codominant trees in the stand at the age of 100 years. These are the larger trees, whose crown forms the general level of the forest canopy and, in a few places, extends above it.

In the Marion County Area, dominant and codominant trees growing in a well-stocked stand on site class 1 soils will reach a height of 186 feet or more at the age of 100 years; those on site class 2 soils will reach heights of 155 to 185 feet; those on site class 3 soils, heights of 125 to 155 feet; those on site class 4, heights of 95 to 125 feet; and those on site class 5, heights of less than 95 feet. In the survey area, only Horeb loam, 2 to 20 percent slopes, is in site class 1. All other soils rated for woodland use are in site classes 2 and 3.

TABLE 2.—*Mean annual growth of Douglas-fir by age and stated site classes*

BOARD FEET PER ACRE, TREES 12 INCHES OR MORE IN DIAMETER [1] [2]

Age of trees (years)	Site class 3			Site class 2		
	Site index 130	Site index 140	Site index 150	Site index 160	Site index 170	Site index 180
30	0	10	30	50	87	133
40	65	112	162	222	298	388
50	168	248	340	444	548	654
60	300	397	493	603	713	821
70	398	503	607	714	820	923
80	462	571	679	776	875	975
90	503	611	711	910	991	1080
100	524	628	724	818	904	989
CUBIC FEET PER ACRE, TOTAL STAND [3]						
30	99	110	120	127	137	144
40	117	131	144	154	164	172
50	126	141	155	166	177	186
60	129	145	158	170	181	191
70	130	146	158	170	181	190
80	128	142	155	167	178	186
90	124	138	150	162	173	182
100	119	133	145	156	166	176

[1] Scribner rule.
[2] Adapted from table 4, USDA Tech. Bul. 201 (*7*).
[3] Adapted from table 22, USDA Tech. Bul. 201 (*7*).

The average annual acre yield for unmanaged, fully stocked stands of Douglas-fir at the age of 100 years is shown in table 2. Data from this table and from the average site indexes shown in the descriptions of woodland suitability groups can be used by the landowner to determine the potential productivity of his soils for wood crops.

In many wooded areas, inadequate natural regeneration results in an understocked stand. Such a stand produces less wood per acre than is shown in table 2. Under improved management, natural regeneration is supplemented where needed, or it is replaced by planting and seeding. The resulting fully stocked stand is protected from fire, insects, and diseases. This level of management can be expected to produce wood in the quantities shown in table 2.

Under a high level of management, yields even higher than those shown in table 2 can be obtained. Under this level of management, fully stocked stands are not only protected from fire, insects, and diseases, but they are also thinned, fertilized, and improved through intermediate harvest cuttings. The trees may also be pruned to improve the quality of the wood. Soils suited to a high level of management generally have slopes of less than 30 percent. They have moderate to high production potential and have few serious limitations to use as woodland. In this category are the soils in woodland suitability groups 1o1, 2o1, 2c1, 3o1, 3o2, 3c1, 3c2, and 3c4.

Slopes of 30 to 50 percent increase the difficulty of applying a high level of management. Applying cultural practices and making harvesting cuttings are extremely difficult. In this category are soils of woodland suitability groups 2c2, 3c3, 3r1, and 3r3. Slopes in excess of 50 percent restrict most management practices to those that can be applied by aerial methods. Soils of woodland suitability groups 2c3, 3r2, and 3r4 are in this category.

LIMITATIONS AND HAZARDS.—Five factors that affect suitability of a site for wood products are related to the soils. These factors are equipment limitations, plant competition, seedling mortality, and the hazards of windthrow and erosion. These factors are discussed for each group of soils under the heading "Woodland Suitability Groups."

Equipment limitations refer to those soil characteristics that restrict the use of logging equipment so that damage to the soils or trees will be prevented. Limitations are given a rating of *slight*, *moderate*, or *severe*. A rating of *slight* means that heavy equipment should not be used in wet periods. A rating of *moderate* means that uses of equipment are moderately restricted by gradient, wetness, stoniness, or other physical properties of the soils, and by the risk of injury to the soils or trees. A rating of *severe* means that special equipment is needed for managing or harvesting the trees, and that the use of this equipment is severely restricted by one or more of the soil characteristics listed for moderate limitations.

Plant competition refers to the invasion and rate of growth of undesirable plants when openings are made in the forest canopy. Competition is *slight* if it does not prevent adequate natural regeneration and early growth of the trees or if it does not interfere with adequate development of planted seedlings. A rating of *moderate* means that competition from undesirable plants hinders but does not prevent the growth and establishment of desirable tree seedlings and the eventual development of a fully stocked stand. A rating of *severe* means that undersirable plants prevent adequate natural or artificial regeneration without intensive preparation and maintenance of the site.

Seedling mortality refers to the loss of naturally occurring or planted tree seedlings as influenced by kinds of soil or topography when plant competition is assumed not to be a limiting factor. A rating of *slight* means that the expected seedling mortality is 0 to 25 percent; a rating of *moderate* means that the expected seedling mortality is between 25 and 50 percent; and a rating of *severe*, that it is more than 50 percent.

Windthrow hazard refers to the danger of trees being blown over by wind. The rating is *slight* where normally no trees are blown over by commonly occurring winds. A rating of *moderate* means that some trees are expected to be blown over during periods when wind is excessive and the soils are wet. A rating of *severe* means that many trees are expected to be blown over during periods when the soil is wet and the velocity of the wind is moderate to high.

Erosion hazard refers to the degree of potential soil erosion. The rating is *slight* where problems of erosion control are not important. A rating of *moderate* means that some attention must be given to prevent unnecessary soil erosion. A rating of *severe* means that intensive treatments and specialized equipment must be used and that methods of operation must be planned to minimize deterioration of the soils.

Special woodland products refer to such special and supplementary woodland products as Christmas trees and cascara bark. Ratings given to show suitability of the soils for these products are *well suited*, *moderately well suited*, and *poorly suited*.

Woodland suitability groups

Soils in the survey area have been placed in woodland suitability groups, mainly according to their potential productivity for Douglas-fir. A woodland group consists of soils that have about the same capability for producing a similar kind of wood crop and that need about the same kind of management.

Woodland suitability groups are identified by a three-digit designation, for example 1o1. The first digit is a numeral that corresponds to the site class (the soils are in site classes 1, 2, or 3) as determined from measurements of tree heights in plot studies. The second digit in the designation is a lowercase letter of the alphabet, either *o*, *c*, or *r*. The letter *o* means that the soils in the group have no significant limitation to woodland management; the letter *c* means that woodland management is limited by clay in the upper part of the soil profile; and the letter *r* means that woodland management is limited by steep slopes. The third digit is a numeral that separates the groups according to degrees of difficulty in applying woodland management. A numeral *3*, for example, means that woodland management is more difficult to apply than if the numeral were a *1* or a *2*.

In the following paragraphs, the woodland suitability groups are discussed. Not all soils in the survey area have been placed in these groups, because some of the soils are too extensively used for growing vegetables, berries, and other crops of high value to be used for trees. Others are not well suited to conifers. The names of soil series represented are mentioned in the description of each woodland suitability group, but this does not mean that all the soils of a given series are in the group. To find the names of all the soils in any given woodland suitability group, refer to the "Guide to Mapping Units" at the back of this survey.

WOODLAND SUITABILITY GROUP 1o1

Horeb loam, 2 to 20 percent slopes, is the only soil in this woodland group. This soil is moderately well drained. It is subject to seepage, and it receives runoff from higher areas. Permeability and the available water capacity are both moderate. Runoff is medium, and erosion is a slight to moderate hazard. The water table is high during winter and spring.

Douglas-fir is the principal species growing on this soil. Western hemlock is the principal species in a few places, but it is present in the understory in many places. Red alder quickly invades recently cutover areas. Common understory plants are vine maple, hazel, swordfern, salal, low Oregongrape, red huckleberry, and oxalis. Brackenfern produces lush growth in open areas. Douglas-fir is used for saw logs, peelers, poles, and pilings. Red alder grows to saw-log size.

This soil is in site class 1 for Douglas-fir. The site index for Douglas-fir is about 186.

Equipment limitations are severe. Water from seepage and runoff make this soil wet most of the time during winter and spring. Also, this soil is unstable if used for roads. It is subject to slumping, and it contains numerous seep areas. Drainage is needed in areas to be used for roads. The roads should be surfaced with rock.

Plant competition is severe. Hardwood trees, shrubs, and a lush growth of brackenfern generally prevent Douglas-fir from becoming established in areas where undesirable plants are not controlled, and they smother or retard the growth of young trees. In logged areas Douglas-fir should be encouraged to regenerate and to establish a stand before hardwoods, brush, and ferns can become established. In these areas planting and mechanical or chemical control of undesirable species may be necessary.

Seedling mortality is slight. Natural regeneration, direct seeding, or planting is suitable for establishing a stand. In some areas preparation of the seedbed is necessary if a stand of seedlings is to be quickly established. Thinning and weeding are commonly needed for development of a full stand. Intermediate harvest cutting is generally feasible.

The hazard of windthrow is moderate. Roots can penetrate to a depth of 3 feet or more, although the depth to which they can penetrate is restricted by the seasonal high water table. Blowdown takes place in winter and spring during storms of higher than normal intensity. Use of special methods, such as properly spacing the trees, improving cutting practices, and using shorter rotations, should be considered to minimize damage from blowdown.

Because the trees grow too rapidly and competition from undesirable plants is severe, this soil is poorly suited to use for growing Christmas trees. Swordfern is abundant in most areas, however, and this plant is often harvested for sale.

The surface layer should not be disturbed unnecessarily. In most places the ground cover is adequate for controlling sheet erosion, but gullying can occur along roads, landings, and fire lanes if the surface layer is disturbed. Roads and landings should be carefully located, constructed, and maintained to protect this soil from erosion.

WOODLAND SUITABILITY GROUP 2o1

This group consists of well-drained, deep and very deep Hullt and McCully soils on foot slopes of the Cascade Mountains. These soils have been extensively cleared for cultivated crops, but more than half of the acreage is used as woodland. The soils have slopes of 2 to 30 percent. They have a surface layer of clay loam or stony clay loam and a subsoil of silty clay loam and clay. Permeability is moderately slow, and the available water capacity is high. Fertility is low. Runoff is slow to rapid, and the hazard of erosion is slight to severe.

Douglas-fir is the principal species growing on these soils, but a few western hemlocks, red alders, and bigleaf maples are mixed in the stands of Douglas-fir. Common plants in the understory are vine maple, hazel, swordfern, salal, and snowberry. Brackenfern makes a lush growth in areas that have been logged or burned over. Thinning to achieve proper spacing between the trees is beneficial, and intermediate harvest cutting is feasible. Douglas-fir is harvested for saw logs, poles, pilings, and peelers.

These soils are in site class 2 for Douglas-fir. The site index for Douglas-fir is higher on the McCully than on the Hullt soils.

Equipment limitations are slight in summer and early in fall, when these soils are dry, except where the slopes are moderately steep. During wet periods, the soils are subject to damage if heavy equipment is used. Roads that are used when the soils are wet require a large amount of rock. During wet periods, wheeled equipment, especially, cuts into the soils, and it can cause gullying. Stones on the surface, and areas of rock outcrop, increase the difficulty of operating logging equipment.

Plant competition develops rapidly, and it is severe. Shrubs and hardwoods smother and interfere with the growth of young seedlings. Weeding stands of young trees is usually necessary. The stand of Douglas-fir should be established immediately after logging is completed, before undesirable plants have had time to become established.

Because of the favorable available moisture-supplying capacity of the soils, seedling mortality is slight. Also, the temperature is not so high as in areas of the low foothills. Establishing a stand of trees through natural regeneration is usually successful. Some areas may need additional planting, however, for a fully stocked stand or to overcome the lack of a natural source of seed. Direct seeding is sometimes unsuccessful, except where conditions are the most favorable. Results from direct seeding are slightly better on northern exposures than in other places.

The hazard of windthrow is slight. Tree roots can penetrate to a depth of more than 3 feet in most places.

These soils are well suited to use for growing Christmas trees, but extensive shearing is needed to control the form of the trees. Cascara commonly grows on these soils.

Careful location, construction, and maintenance of roads, skid trails, landings, and fire lanes are needed to control erosion. The surface layer should be disturbed as little as possible.

WOODLAND SUITABILITY GROUP 2c1

This group consists of well-drained Horeb soils that have slopes of 0 to 35 percent. These soils have a surface layer of gravelly silt loam, and they are underlain by very gravelly sand at a depth of about 40 inches. Permeability and the available water capacity are both moderate, and fertility is low. Runoff is slow to rapid, and the hazard of erosion is slight to severe.

Douglas-fir is the principal species growing on these soils, but a few western hemlocks, red alders, and bigleaf maples grow in places. Common plants in the understory are vine maple, hazel, swordfern, salal, and snowberry. Brackenfern makes a lush growth in areas that have been logged or burned over. Thinning to achieve proper spacing of the trees is beneficial, and intermediate harvest cutting is feasible. Douglas-fir is harvested for saw logs, poles, pilings, and peelers.

These soils are in site class 2 for Douglas-fir. The site index for this species is about 167.

Except where the slopes are moderately steep, equipment limitations are slight in summer and early in fall, when these soils are dry. During wet seasons, these soils are subject to damage if heavy equipment is used.

Plant competition develops rapidly and is severe. Shrubs and hardwoods may smother young seedlings or interfere with their growth. Weeding stands of young trees is usually needed. A stand of Douglas-fir should be established immediately after logging is completed, before undesirable plants have had time to become established.

Seedling mortality is slight. Natural regeneration is generally successful for establishing a stand, but planting is needed in some areas to achieve full stocking of the stand or to overcome the lack of a natural source of seed. Direct seeding, except under the most favorable conditions, is sometimes unsuccessful.

The hazard of windthrow is slight. Tree roots can grow to a depth of about 40 inches.

These soils are well suited to use for growing Christmas trees, but extensive shearing is needed to control the form of the trees. Cascara commonly grows on these soils.

Careful location, construction, and maintenance of roads, skid trails, landings, and fire lanes are needed to control erosion. The surface layer should be disturbed as little as possible.

WOODLAND SUITABILITY GROUP 2c2

This group consists of well-drained, deep and very deep Hullt and McCully soils on foot slopes of the Cascade Mountains. These soils are steep. They have a surface layer of clay loam and a subsoil of silty clay loam or clay. Permeability is moderately slow, the available water capacity is moderate to high, and fertility is low. Runoff is rapid, and the hazard of erosion is severe.

Douglas-fir is the principal species growing on these soils, but a few western hemlocks, red alders, and bigleaf maples grow in places. Common plants in the understory are vine maple, hazel, swordfern, salal, and snowberry. Brackenfern produces a lush growth in open areas and in areas that have been logged or burned over. Douglas-fir is used for saw logs and peelers. The steep slopes limit such practices as thinning, intermediate harvest cutting, and tractor logging.

These soils are in site class 2 for Douglas-fir. The site index for Douglas-fir is about 168 on the McCully soil and about 151 on the Hullt soil.

Equipment limitations are moderate in summer and early in fall, when these soils are dry. They are severe in winter and at other times when the soils are wet. Roads to be used when the soils are wet require a large amount of rock. These soils are poorly suited to use of wheeled equipment. In some places rock outcrops or stones on the surface increase the difficulty of operating equipment. Cable logging disturbs the soils less than other methods.

Plant competition is severe. Unless brackenfern, shrubs and hardwoods are controlled, they prevent Douglas-fir from becoming established. They also smother many of the small seedlings, and they retard the growth of young trees. The stand of Douglas-fir should be established immediately after logging is completed, before undesirable plants have had time to become established. Weeding stands of young trees is generally necessary.

Because of the favorable available moisture-supplying capacity of the soils, seedling mortality is slight. Also, the temperature is generally not so high as in the areas of low foothills. The Hullt soil is transitional, however, between the lower and the higher elevations. A greater number of seedlings are lost in low-lying areas of that soil than on the McCully soil. Establishing a stand of trees through natural regeneration is usually successful. Some areas may need additional planting, however, for a fully stocked stand or to overcome the lack of a natural source of seed. Direct seeding is sometimes unsuccessful, except where conditions are the most favorable. Results from direct seeding are slightly better on northern exposures than in other places.

The hazard of windthrow is moderate. Roots can penetrate to a depth of more than 3 feet in most places. Some blowdown occurs during winter and spring, when storms are accompanied by higher than normal precipitation and winds of high velocity.

These soils are moderately well suited to use for growing Christmas trees, but extensive shearing is needed to control the form of the trees. Steep slopes make management of the trees difficult.

Careful construction and maintenance of roads, skid trails, and fire lanes are needed to control erosion. The surface layer should be disturbed as little as possible.

WOODLAND SUITABILITY GROUP 2c3

McCully clay loam, 50 to 70 percent slopes, which is well drained, is the only soil in this group. This soil has a clay subsoil. It is on foot slopes of the Cascade Mountains. Permeability is moderately slow, the available water capacity is moderate to high, and fertility is low. Runoff is rapid or very rapid, and the hazard of erosion is severe.

Douglas-fir is the principal species growing on this soil, but a few western hemlocks, red alders, and bigleaf maples grow in a few places. Common plants in the understory are vine maple, hazel, swordfern, salal, and snowberry. Brackenfern produces lush growth in open areas or in areas that have been burned or logged over. Douglas-fir is harvested for saw logs and peeler logs. The steep slopes limit, and in most places prohibit, planting, thinning, intermediate harvest cutting, and tractor logging.

This soil is in site class 2 for Douglas-fir. The site index for Douglas-fir is about 168.

Equipment limitations, especially for tractors, are severe because of the steep slopes and the low bearing capacity of this soil when wet.

Plant competition is severe. Brackenfern, shrubs, and hardwoods interfere with the establishment of trees, and they smother or retard the growth of young trees. In logged areas a stand of Douglas-fir should be established before hardwoods, brush, and ferns can become established.

Seedling mortality is slight because of the moderate to high available water capacity of this soil. Also, the temperature is favorable for the growth of Douglas-fir. Both natural regeneration and direct seeding are used to obtain a satisfactory stand of Douglas-fir. Seedlings are more likely to survive on north-facing than on south-facing slopes.

The hazard of windthrow is slight because tree roots can penetrate to a depth of more than 3 feet. In winter and spring, some blowdown occurs during storms that are accompanied by higher than normal amounts of precipitation and wind velocity.

Steep slopes make this soil poorly suited to use for growing Christmas trees, because shearing of the trees would be difficult. A few cascara trees grow on this soil.

During logging, disturbance of the surface layer should be kept to a minimum. Careful location, construction, and maintenance of roads, fire lanes, and landings are needed to control erosion.

WOODLAND SUITABILITY GROUP 3o1

Kinney cobbly loam, 2 to 20 percent slopes, on foot slopes of the Cascade Mountains, is the only soil in this group. This soil is deep and well drained, and it has a subsoil of clay loam. Permeability and fertility are both moderate, and the available water capacity is low to moderate. Runoff is medium, and the hazard of erosion is slight. This soil is still used as woodland because its cobbly surface layer and the unfavorable climate limit its use for cultivated crops.

Douglas-fir is the principal species growing on this soil, but a significant amount of western hemlock is mixed in the stand. Also, a few silver firs grow at the higher elevations. Common plants in the understory are vine maple, salal, low Oregongrape, red huckleberry, swordfern, and oxalis. Red alder and brackenfern are moderately aggressive in cutover areas. Douglas-fir is harvested for poles, pilings, saw logs, and peelers. Western hemlock and silver fir are harvested for saw logs and pulpwood. As a rule, red alder does not grow to saw-log size.

This soil is in site class 3 for Douglas-fir. The site index for this species is about 145.

Equipment limitations are slight. Wheel or crawler types of equipment are well suited to use for logging on this soil. The cobbly nature and good drainage of this soil provide favorable conditions for logging in winter. A minimum amount of gravel is needed on roads that are used in winter, but snow may interfere with logging.

Plant competition is moderate. Vegetation in the understory is mostly low growing, and it spreads at a moderately slow rate. Weeding stands of young trees to rapidly achieve full stocking is desirable.

Seedling mortality is moderate. This soil has moderate to moderately low available water capacity, but moisture tends to be inadequate for young seedlings late in spring and in summer. Natural regeneration, direct seeding, and planting are used to reestablish a stand of desirable trees in areas that have been logged. Such areas eventually become well stocked with seedlings if an adequate natural source of seed is available. Moderate preparation of the seedbed is beneficial.

The hazard of windthrow is slight. Tree roots can penetrate to a depth of 40 to 60 inches. A moderate amount of blowdown occurs during wet periods where this soil is shallow and the trees are growing on exposed ridges.

This soil is well suited to use for growing Christmas trees. Douglas-fir, silver fir, and noble fir grow well. They need a moderate amount of shearing and weeding. Careful construction and maintenance of roads, skid trails, and landings are needed to control erosion.

WOODLAND SUITABILITY GROUP 3o2

This group consists of well-drained, stony and very stony Henline and Whetstone soils that have a surface layer of loam or sandy loam. These soils are moderately deep, and they have slopes of 3 to 30 percent. They occupy foot slopes of the Cascade Mountains. Permeability is moderate to moderately rapid, and the available water capacity is low or very low. Fertility is low. Runoff is medium, and the hazard of erosion is moderate.

Noble fir, silver fir, and western hemlock are the dominant forest trees. Mixed with these species is a substantial amount of Douglas-fir. Plants commonly growing in the understory are vine maple, blue huckleberry, thimbleberry, rhododendron, beargrass, and fireweed. Noble fir, silver fir, and Douglas-fir are harvested for saw logs and peeler logs. Western hemlock is harvested for saw logs and pulpwood.

These soils are in site class 3 for Douglas-fir. The site index for Douglas-fir on the Henline soil is 137. The site index for this species on the Whetstone soil is 140. The site indexes are not uniform for either soil, however, because of the variability in elevation and in the depth of the soils.

Equipment limitations are slight. The soils can be used when wet, but they are generally covered with snow during winter and spring. Rock outcrops can be a minor hazard where tractors are used for constructing roads and fire lanes. Thinning and intermediate harvesting cutting can be performed on soils of this group.

Plant competition is moderate. Undesirable plants are generally low growing, and they provide only a moderate obstacle to the regeneration and growth of fir and hemlock.

Seedling mortality is slight. Summers are short, and they are cool and dry. Frost heaving is a hazard in places, especially where the soil is bare. Natural regeneration is good. Direct seeding and planting are feasible, and little weeding is needed.

The hazard of windthrow is generally slight, but it is moderate on exposed ridges where the soil is shallow. Tree roots can penetrate to a depth of 20 to 40 inches. Trees growing at the higher elevations are generally shorter and more widely spaced than those growing at the lower elevations.

Silver fir, noble fir, and Douglas-fir can be grown for Christmas trees, and a minimum of weeding and shearing is required. Harvesting the Christmas trees may be difficult in most years, however, because of snow.

Care should be taken in logging so that the understory plants are not excessively damaged. Carefully locating, constructing, and maintaining roads, skid trails, and landings are necessary to control erosion.

WOODLAND SUITABILITY GROUP 3c1

This group consists of well-drained Jory, Nekia, Salkum, and Silverton soils that have a surface layer of silty clay loam or silt loam and a subsoil of clay, silty clay, or gravelly silty clay. These soils are moderately deep to very deep and have slopes of 0 to 30 percent. They are on low foothills of the Cascade Mountains. Some of them are stony. Permeability is moderately slow, and the available water capacity is low to high. Fertility is low to moderate. Runoff is slow to rapid, and the hazard of erosion is slight to severe. Because of their value for farming, these soils have been cleared extensively. Use as woodland is considered to be only temporary, except for a few plantings intended for the production of Christmas trees.

Douglas-fir is the principal species growing on these soils, but the stands are mixed, and variable amounts of cascara and Oregon white oak grow in places. Typical in the understory are hazel, cascara, snowberry, trailing blackberry, and poison-oak.

Soils in this group are in site class 3 for Douglas-fir.

Equipment limitations are slight, but they are more severe on strong slopes. Wheeled equipment is suitable for use during the dry weather in summer and in fall. Use of crawler types of equipment is feasible during wet periods.

Plant competition is moderate. Oregon white oak sprouts after a stand is cutover or is burned over, and it interferes with the growth of Douglas-fir.

Seedling mortality is moderate to severe. It is caused by the shortage of soil moisture late in summer, and also by the competition from other plants that grow rapidly during mild weather in winter and spring.

The hazard of windthrow is slight. Tipover sometimes occurs during rainy periods, when the soils are saturated and the water table rises because of heavy rains. Tree roots can generally penetrate to depths of 20 to 60 inches or more.

These soils are well suited to use for growing Christmas trees of many different species. Plantings intended for the production of Christmas trees can be readily tilled and managed. Cascara is abundant in cutover areas.

Careful location, construction, and maintenance of roads, skid trails, fire lanes, and landings are needed to control erosion.

WOODLAND SUITABILITY GROUP 3c2

This group consists of well-drained, very stony McCully and Nekia soils that have a clay subsoil. These soils are moderately deep to very deep and have slopes of 2 to 30 percent. They are on low foothills. Permeability is moderately slow, and the available water capacity is low. Fertility is low. Runoff is medium, and the hazard of erosion is slight or moderate.

Because of the stones in the surface layer, and because of the strong slopes in many places, most areas of these soils are wooded or are in woodland pasture. Only small areas have been cleared and cultivated. In the wooded areas, regeneration of the stands has been poor in many places because of inadequate management.

Douglas-fir is the principal species growing on these soils, but stands on the Nekia soil contain variable amounts of Oregon white oak. On the Nekia soils, the plants in the understory are mainly hazel, snowberry, trailing blackberry, and poison-oak. On the McCully soil, the plants in the understory are mainly vine maple, hazel, swordfern, salal, and snowberry. Douglas-fir is harvested for saw logs, poles, and pilings.

The Nekia soil is in site class 3 for Douglas-fir, and for that soil the site index for Douglas-fir is 140. The McCully soil is in site class 3 for Douglas-fir. For that soil the site index for Douglas-fir is 150.

Equipment limitations are slight, but they increase on strong slopes. Rock outcrops increase the difficulty of building roads and of operating equipment. During the dry weather in summer and fall, these soils are suitable for use of wheeled equipment. Crawler equipment can be used during the wet parts of the year.

Plant competition is moderate to severe. On the Nekia soil, Oregon white oak interferes with the growth of Douglas-fir in many places. On the McCully soil, competition from brackenfern, brush, and hardwoods is severe for seedlings of Douglas-fir and for young trees of this species. A stand of Douglas-fir should be regenerated immediately after an area is logged so that unwanted competition will be reduced. Weeding to remove oaks, other hardwoods, and brush is necessary to obtain full development of young trees in stands of Douglas-fir. Thinning to achieve proper spacing of the trees is desirable. Intermediate harvest cuttings are feasible.

Because of inadequate moisture late in summer, seedling mortality is moderate on the McCully soil, and it is moderate to severe on the Nekia soil. Natural regeneration produces a spotty stand. Planting is needed in many places to obtain a fully stocked stand. Direct seeding is not usually successful, except where it is done under the most favorable conditions.

The hazard of windthrow is slight. Tree roots can penetrate to a depth of 20 to 60 inches or more. Some tipover occurs during the rainy season, when the soils are likely to be saturated.

These soils are moderately well suited to use for growing Christmas trees, although stones interfere with cultivation. Local markets for Christmas trees are easily accessible. On the cooler sites, the trees require extensive shearing if a good form is to be developed. Cascara is common on the soils of this group.

Careful construction and maintenance of roads, skid trails, fire lanes, and landings are needed to control erosion.

WOODLAND SUITABILITY GROUP 3c3

This group consists of well-drained, moderately deep, stony and nonstony Nekia soils that have a clay subsoil. These soils have slopes of 30 to 50 percent. They are on low foothills. Permeability is moderately slow, and the available water capacity is low to moderate. Runoff is rapid or very rapid, and the hazard of erosion is severe.

Soils of this group are used as woodland or as woodland pasture because they are too steep or too stony for cultivation. A few areas have been cleared and cultivated. Regeneration of the stand of trees has been poor as the result of inadequate management.

Douglas-fir is the principal species growing on these soils, but the stands contain variable amounts of Oregon white oak. Plants in the understory are hazel, snowberry, trailing blackberry, and poison-oak. Douglas-fir is harvested for saw logs, poles, and pilings.

These soils are in site class 3 for Douglas-fir. The site index for this species is 140.

Equipment limitations are moderate, but they are more severe where the amount of stones is greatest or where rock outcrops occur. Rock outcrops increase the difficulty of building roads. Steep slopes, stones, and rock outcrops also increase the difficulty of logging, and they make necessary the use of crawler tractors or cable equipment.

Plant competition is moderate. Oregon white oak interferes with the growth of young Douglas-fir in many places. Oak and brush are generally weeded from stands of young Douglas-fir so that the young trees can attain proper growth. Thinning to achieve proper spacing of the trees is desirable. Intermediate harvest cuttings can be made, but they are difficult because of the steep slopes.

Seedling mortality is moderate to severe as a result of a shortage in soil moisture late in summer, and because of the dense growth of competing plants that grow rapidly during mild weather in winter and spring. Natural regeneration results in a spotty stand in places. Planting is necessary to obtain a fully stocked stand.

The hazard of windthrow is slight. Tipover can occur during rainy seasons when the soil is saturated.

These soils are moderately well suited to use for growing Christmas trees of many different species. Local markets for Christmas trees are nearby and are readily accessible. The soils cannot be tilled, and they are difficult to plant and to manage for Christmas trees. Cascara commonly grows on cutover land.

Careful location, construction, and maintenance of roads, skid trails, fire lanes, and landings are necessary to control erosion.

WOODLAND SUITABILITY GROUP 3c4

Only one soil, Cumley silty clay loam, 2 to 20 percent slopes, which is on foot slopes of the Cascade Mountains, is in this group. This soil is very deep, and it is moderately well drained. It has a clay subsoil. Permeability is moderately slow, the available water capacity is high, and fertility is low. Seepage and runoff are received from higher areas. Runoff is medium, and the hazard of erosion is slight.

Douglas-fir is the principal species growing on the soil. Western hemlock is mixed in the stand in a few places, and its grows in the understory in many places. Red alder quickly invades in areas recently logged. Common plants in the understory are vine maple, hazel, swordfern, salal, low Oregongrape, red huckleberry, and oxalis. Brakenfern produces a lush growth in open areas. Douglas-fir is harvested for saw logs, peelers, poles, and pilings. Red alder grows to saw-log size.

This soil is in site class 3 for Douglas-fir. The site index for this species is 145.

Equipment limitations are severe. This soil is subject to slumping, and it contains many seepy areas that make operation of equipment difficult. Runoff and seepage from other areas make this soil wet most of the time in winter and spring. Roads and the side slopes of cuts are unstable. Drainage is needed in areas to be used for roads, and rock should be added.

Plant competition is severe. Hardwoods, shrubs, and brackenfern prevent Douglas-fir from becoming established in some areas where undesirable plants are not controlled, and they smother or retard the growth of young trees. A stand of Douglas-fir should be established promptly after logging is completed so that competition from undesirable plants will be reduced. Planting and also mechanical and chemical eradication of competing vegetation may be necessary in some cutover areas.

Seedling mortality is slight. Natural regeneration, direct seeding, or planting can be used for establishing a stand. In places preparation of the seedbed is necessary if a stand of seedlings is to be quickly established. Weeding and thinning are generally needed to obtain a fully developed stand. Intermediate harvest cutting is generally feasible.

The hazard of windthrow is severe. A seasonal high water table restricts penetration of tree roots to less than 4 feet. Blowdown occurs in winter and spring during storms that are accompanied by higher than normal wind velocity. Proper spacing of the trees, use of shorter rotations, and improved practices of selecting trees for cutting can minimize losses from windthrow.

The rapid growth of undesirable plants and the severe competition from those plants make this soil poorly suited to use for growing Christmas trees. Swordfern is abundant in most places, and it is harvested for sale.

The surface layer should not be disturbed unnecessarily. In most places the ground cover is adequate for controlling sheet erosion, but gullying can occur along roads, landings, and fire lanes if the surface layer is disturbed. Roads and landings should be carefully located, constructed, and maintained to protect this soil from erosion.

WOODLAND SUITABILITY GROUP 3r1

The only soil in this group is Kinney cobbly loam, 20 to 50 percent slopes, which is on foot slopes of the Cascade Mountains. This soil is deep and well drained, and it has a subsoil of clay loam. Permeability is moderate, and the available water capacity is low to moderate. Fertility is moderate. Runoff is rapid, and the hazard of erosion is moderate. Because of the steep slopes, the cobbly surface layer, the many rock outcrops, and a climate that limits use for cultivated crops, this soil has remained in trees.

Douglas-fir is the principal species growing on this soil, but a significant amount of western hemlock is mixed in the stand. At higher elevations the stands also contain a few silver and noble firs. Common plants in the understory are vine maple, salal, low Oregongrape, red huckleberry, swordfern, and oxalis. Red alder and brackenfern are moderately aggressive invaders in cutover areas. Douglas-fir is harvested for saw logs, poles, piling, and peelers. Western hemlock, silver fir, and noble fir are harvested for saw logs and pulpwood. Red alder generally does not grow to saw-log size.

This soil is in site class 3 for Douglas-fir. The site index for this species is about 145.

Equipment limitations are moderate as a result of the steep slopes and numerous cobblestones. The cobblestones and the good drainage make this soil suitable for tractor logging in winter, except in steep areas. Cable equipment is needed for the places that are steep.

Plant competition is moderate. Plants in the understory are low growing, and they spread at a moderately slow rate. Weeding is desirable to quickly achieve a fully stocked stand.

Seedling mortality is moderate. Soil moisture for seedlings is in short supply late in spring and in summer. Natural regeneration, direct seeding, and planning are used to reestablish a stand of Douglas-fir in cutover areas. Where a natural source of seed is adequate, cutover areas gradually become well stocked as the result of natural reproduction. Moderate preparation of the seedbed is beneficial.

The hazard of windthrow is slight. Tree roots can penetrate to a depth of 40 to 60 inches. Moderate blowdown sometimes occurs in winter on exposed ridges where this soil is shallow.

Its steep slopes make this soil only moderately well suited to use for growing Christmas trees. Douglar-fir and silver and noble firs grow well, and they need only a moderate amount of weeding and shearing.

Careful location, construction, and maintenance of roads, skid trails, and landings are needed to control erosion.

WOODLAND SUITABILITY GROUP 3r2

Kinney cobbly loam, 50 to 70 percent slopes, on foot slopes of the Cascade Mountains, is the only soil in this group. This soil is deep and well drained, and it has a clay loam subsoil. Permeability is moderate, the available water capacity is low to moderate, and fertility is moderate. Runoff is rapid, and the hazard of erosion is severe.

Douglas-fir is the principal species growing on this soil, but a significant amount of western hemlock is in the stand. At higher elevations the stands also contain a few silver firs. Common understory plants are vine maple, salal, low Oregongrape, red huckleberry, swordfern, and oxalis. Red alder and brackenfern are moderately aggressive invaders in cutover areas.

Douglas-fir and western hemlock are harvested for saw logs, peelers, and pulpwood. Poles and pilings are seldom harvested because of the difficulty of making intermediate cuttings on the steep slopes. Red alder seldom grows to commercial size.

This soil is in site class 3 for Douglas-fir. The site index for this species is about 145.

Equipment limitations are severe. The steep slopes limit the intensity of management, and they restrict planting, weeding, thinning, intermediate cutting, and use of tractors for logging. Cable equipment is generally used in logging. This soil has features that make it a good base for roads, and it is stable in cuts.

Plant competition is moderate. Plants in the understory are generally low growing, and they spread slowly after an area is logged.

Seedling mortality is moderate. This soil has moderate available water capacity, and soil moisture for seedlings is in short supply late in spring and in summer. Natural regeneration or direct aerial seeding is used to reestablish a stand of Douglas-fir after an area is logged. A fully stocked stand is gradually reestablished in most cutover areas if an adequate natural source of seed is near. The steep slopes limit weeding and the preparation of the seedbed to the application of chemicals.

The hazard of windthrow is slight. Tree roots can penetrate to a depth of 40 to 60 inches. Moderate blowdown occurs on exposed ridges where this soil is shallow.

This soil is not suitable for growing Christmas trees, because of its steep slopes and the difficulty of managing and harvesting the crops. Cable equipment should be used during logging to protect the surface layer from excessive damage. Careful location, construction, and maintenance of roads and landings are needed to control erosion.

WOODLAND SUITABILITY GROUP 3r3

This group consists of well-drained, moderately deep Henline and Whetstone soils that have a surface layer of very stony sandy loam or stony loam. These soils have slopes of 25 to 55 percent. They occupy uplands of the Cascade Mountains. Permeability is moderate to moderately rapid, and the available water capacity is low or very low. Fertility is low. Runoff is rapid, and the hazard of erosion is severe.

Noble fir, silver fir, and western hemlock are the dominant species of trees growing on these soils, but a substantial amount of Douglas-fir is mixed in the stands. Common plants in the understory are vine maple, thimbleberry, rhododendron, beargrass, and fireweed. Noble fir, silver fir, and Douglas-fir are harvested for saw logs and peeler logs. Hemlock is cut for saw logs and pulpwood.

The soils in this group are in site class 3 for Douglas-fir. On the Henline soil, the site index for Douglas-fir is 137. On the Whetstone soil, the site index for this species is 140. Site indexes range from 120 to 150, however, because of the variability in elevation and in the depth of the soils. Site indexes are not available for noble fir, silver fir, and western hemlock, but these species appear to produce about as much wood as Douglas-fir.

Equipment limitations are moderate. These soils can be used when wet, but they are generally covered with snow during winter and spring. The Henline soil is especially subject to slumping and sliding during this part of the year, but neither of the soils should be used in winter and spring. Rock outcrops and escarpments make the use of tractors difficult where roads and fire lanes are to be constructed. Intermediate harvest cuttings and thinnings are generally not feasible.

Plant competition is moderate. The plants in the understory are low growing, and they provide only moderate competition to the regeneration and growth of fir and hemlock.

Seedling mortality is slight. Summers are short, and they are dry and cool. Results from natural regeneration are good. Direct seeding and planting are needed in some areas to reestablish a stand of trees in cutover areas. Bare areas of these soils are subject to frost heave in winter.

The hazard of windthrow is slight, except on exposed ridges where the soils are shallow. Tree roots can penetrate to a depth of 20 to 40 inches. Trees growing at the higher elevations are shorter and more widely spaced than those growing at lower elevations.

Silver and noble firs and Douglas-fir are suitable for Christmas trees, and they need only a minimum amount of weeding and shearing. Snow and steep slopes, however, make this crop difficult to harvest.

Cable equipment should be used in logging so that the plants in the understory will be protected from excessive damage. Careful location, construction, and maintenance of roads and skid trails are necessary to control erosion.

WOODLAND SUITABILITY GROUP 3r4

This group consists of well-drained, moderately deep Henline and Whetstone soils that have a surface layer of very stony sandy loam or stony loam. These soils have slopes of 55 to 80 percent. They are on foot slopes of the Cascade Mountains. Permeability is moderate to moderately rapid, the available water capacity is low or very low, and fertility is low. Runoff is rapid or very rapid, and the hazard of erosion is severe.

Noble fir, silver fir, and western hemlock are the dominant species. In most places the stands also include a moderate amount of Douglas-fir. Common plants in the understory are vine maple, blue huckleberry, thimbleberry, rhododendron, beargrass, and fireweed. Noble fir, silver fir, and Douglas-fir are harvested for saw logs and peeler logs. Western hemlock is cut for saw logs and pulpwood.

These soils are in site class 3 for Douglas-fir. On the Henline soil, the site index for Douglas-fir is 137, and on the Whetstone soil, it is 140. Site indexes range from 120 to 150, however, because of differences in elevation and in depth of the soils.

Equipment limitations are severe. The very steep slopes, rock outcrops, and escarpments severely limit the use of equipment, although the soils can be used when wet. The rock outcrops and escarpments also increase the difficulty of building roads. Logging is done by use of cable equipment.

Plant competition is moderate. Plants in the understory are low growing, and they have a moderate effect on the regeneration and growth of fir and hemlock.

Seedling mortality is slight. Summers are short, and they are dry and cool. Natural regeneration is good, but the steep slopes limit other methods of regeneration to aerial seeding. Weeding is generally not required, but where needed, it is limited to the aerial application of chemicals.

The hazard of windthrow is slight in most places, but it is moderate where these soils are shallow over bedrock. Trees roots can penetrate to a depth of 20 to 40 inches. Trees growing on these soils are generally shorter and more widely spaced than those on soils at lower elevations.

A limited number of Christmas trees could be cut from logged areas, but snow and the poor accessibility of the areas make harvest of the trees difficult. The production of Christmas trees through the use of cultural methods is difficult because of the steep slopes.

Logging methods should be used that protect the understory vegetation from excessive damage. Careful location, construction, and maintenance of roads and landings are necessary to control erosion.

Engineering Uses of the Soils [4]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of engineering projects. The properties most important to engineers are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and reaction. Also important are depth to water table, flooding hazard, depth to bedrock, and relief. Such information is made available in this subsection. Engineers can use it to—

1. Make studies that will aid in selecting and developing sites for industries, businesses, residences, and recreational areas.
2. Make estimates of the engineering properties of soils for use in planning agricultural drainage systems, waterways, farm ponds, irrigation systems, and other structures for conserving soil and water.

[4] ROY FOX, State conservation engineer, Soil Conservation Service, assisted in preparing this section.

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3. Make preliminary evaluations of soils and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables, and in planning more detailed surveys of soils at selected locations.
4. Locate probable sources of sand, gravel, rock, and other materials for use in construction.
5. Correlate pavement performance with soil mapping units, and thus develop information that will be useful in designing and maintaining the pavements.
6. Determine the suitability of soils for cross-country movement of vehicles and of construction and logging equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of preparing reports that can be readily used by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the area.

It should be emphasized that the interpretations made in this survey are not a substitute for the sampling and

TABLE 3.—*Engineering*

Tests performed by the Engineering Experiment Station, Oregon State University, in cooperation with the Oregon State Highway American Association of State

Soil name and location	Parent material	Oregon State University report No.	Depth from surface	Moisture density[1]	
				Maximum dry density	Optimum moisture
			In.	*Lb. per cu. ft.*	*Pct.*
Bashaw clay: NW¼SW¼NE¼ sec. 9, T. 6 S., R. 1 W.	Clayey alluvium.	240–248	14–31	74	26
		240–249	48–60	87	31
Concord silt loam: NE¼NE¼NW¼ sec. 33, T. 5 S., R. 2 W.	Old valley alluvium.	240–250	6–15	99	22
		240–251	19–29	93	25
		240–252	29–60	97	22
Jory silty clay loam: NW¼NW¼NE¼ sec. 13, T. 8 S., R. 3 W.	Basalt.	240–141	0–4	89	29
		240–142	20–28	103	23
		240–143	50–63	93	29
McCully clay loam: SW¼SW¼SE¼ sec. 12, T. 8 S., R. 1 E.	Mixed igneous agglomerate.	240–132	0–8	75	36
		240–133	37–69	87	31
		240–134	69–80	85	32
Nekia silty clay loam: NW¼SW¼NW¼ sec. 17, T. 8 S., R. 1 W.	Basic igneous rock.	240–120	0–6	89	29
		240–121	26–36	92	28
Woodburn silt loam: SW¼SE¼SE¼ sec. 2, T. 4 S., R. 2 W., of the Willamette meridian.	Mixed moderately fine textured alluvial deposits.	240–198	0–9	107	18
		240–199	17–25	110	18
		240–200	54–68	103	22

[1] Based on AASHO designation: T 99–57, Method A (*1*).

[2] Mechanical analyses according to AASHO Designation T 88–57. Results by this procedure frequently differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

testing needed at a site chosen for specific engineering work that involves heavy loads or at a site where excavations are deeper than the depths of the layers here reported. Also, engineers should not apply specific values to the estimates for bearing capacity given in this survey. Nevertheless, by using this survey, an engineer can select and concentrate on those soil units most important for his proposed kind of construction, and in this manner reduce the number of soil samples taken for laboratory testing and complete an adequate soil investigation at minimum cost.

Information of value in planning engineering work is given throughout the text, especially in the sections "Descriptions of the Soils" and "Formation and Classification of Soils."

Some of the terms used by the scientists may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, and sand—may have special meaning in soil science. These and other special terms used in the soil survey are defined in the Glossary at the back of this survey. Most of the information about engineering is given in tables 3, 4, and 5.

test data

Department and the U.S. Department of Commerce, Bureau of Public Roads (BPR), in accordance with standard procedures of the Highway Officials (AASHO) (*1*)]

Mechanical analysis [2]								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than—						AASHO	Unified [3]
No. 4	No. 10	No. 40	No. 200	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
								Pct.			
--------	100	96	89	87	82	56	36	90	55	A-7-5(20)	CH-MH
--------	100	86	69	66	58	37	24	74	44	A-7-5(18)	CH
--------	100	96	91	86	48	23	13	32	9	A-4(8)	CL-ML
--------	100	96	82	71	38	13	5	43	19	A-7-5(12)	CL-ML
--------	100	99	85	65	25	6	2	(4)	(4)	A-4(8)	ML
--------	100	82	65	58	37	16	8	48	15	A-7-5(9)	ML
--------	100	96	85	82	66	44	32	40	18	A-6(11)	CL
--------	100	96	86	82	69	52	42	49	20	A-7-6(14)	ML-CL
100	95	72	51	46	36	18	12	55	9	A-5(4)	MH
--------	100	94	64	58	49	37	24	50	8	A-5(7)	ML
--------	100	97	65	60	50	36	28	53	7	A-5(8)	MH
--------	100	93	80	76	63	30	19	40	12	A-6(9)	ML-CL
--------	100	90	73	68	57	39	29	41	8	A-5(8)	ML
99	93	88	70	62	38	20	11	26	2	A-4(7)	ML
--------	100	95	73	65	41	21	13	29	7	A-4(8)	ML-CL
--------	100	99	83	68	37	12	8	35	11	A-6(8)	ML-CL

[3] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of A-line are to be given a borderline classification. An example of a borderline classification obtained by this use is ML-CL.

[4] Nonplastic. Liquid limit is not determined on nonplastic soils unless they are suspected of having properties that will affect engineering behavior.

TABLE 4.—*Estimated engineering*

[Alluvial land (Ad), Stony rock land (Sy), and Terrace escarpments (Te) are omitted from table because their properties are too variable for of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is

Soil series and map symbols	Hydro-logic group	Depth to bed-rock	Depth to seasonal high water table	Depth from surface	Classification		
					USDA texture	Unified	AASHO
		In.	*In.*	*In.*			
Abiqua (AbA, AbB)	C	72+	60+	0–21	Silty clay loam	ML or CL	A–6
				21–54	Silty clay	ML or CL	A–7
				54–72	Silty clay loam	ML or CL	A–6
Amity (Am)	C	72+	6–12	0–24	Silt loam	ML	A–4
				24–37	Silty clay loam	ML or CL	A–7
				37–60	Silt loam	ML or CL	A–4
Bashaw (Ba)	D	60+	0–6	0–60	Clay	CH	A–7
Camas (Ca)	A	72+	60+	0–9	Gravelly sandy loam	GM	A–1
				9–60	Very gravelly sand	GP	A–1
Chehalem (CeC)	C	60+	6–16	0–16	Silt loam	ML	A–4
				16–60	Silty clay	MH	A–7
Chehalis (Ch)	B	72+	60+	0–80	Silty clay loam	CL or ML	A–6
Chehulpum (Mapped only in an undifferentiated unit with Steiwer soils.)	C	10–20	(3)	0–12	Silt loam	ML	A–4
				12	Hard sandstone.		
Clackamas (Ck)	C	60+	6–16	0–15	Gravelly loam	GM	A–6
				15–24	Gravelly clay loam	GM	A–7
				24–60	Very gravelly clay loam	GM	A–2
Cloquato (Cm)	B	72+	60+	0–65	Silt loam	ML	A–4 or A–6
				65–83	Fine sandy loam	SM	A–4
Concord (Co)	D	72+	0–6	0–15	Silt loam	CL or ML	A–4
				15–29	Silty clay	CL or ML	A–7
				29–60	Silt loam	ML	A–4
Courtney (Cu)	D	72+	0–6	0–12	Gravelly silty clay loam	ML	A–4
				12–24	Gravelly clay	CH	A–7
				24–57	Very gravelly clay loam, very gravelly sand.	GC	A–1 or A–2
Cumley (CLD)	C	60+	18–48	0–9	Silty clay loam	CL or ML	A–6
				9–60	Clay, silty clay	MH	A–7
Dayton (Da)	D	72+	0–6	0–13	Silt loam	ML	A–4
				13–46	Clay	CH	A–7
				46–60	Silty clay loam	ML	A–4
Hazelair (HaB, HaD, HcD2)	D	24–40	12–24	0–18	Silt loam, silty clay loam	ML or CL	A–6
				18–38	Clay, silty clay	CH	A–7
				38	Fractured sandstone.		
Henline (HEE, HEF, HEG)	C	20–40	(3)	0–30	Very stony sandy loam	GM	A–1
				30	Fractured basalt.		
Holcomb (Ho)	D	72+	6–16	0–24	Silt loam, silty clay loam	ML	A–4
				24–42	Clay and silty clay	CH	A–7
Horeb:							
(HRD)	B	60+	30–40	0–14	Loam	ML	A–4
				14–36	Gravelly loam	ML or SM	A–4
				36–60	Cobbly loam	ML or GM	A–4 or A–1
(HSC, HSE)	B	72+	60+	0–40	Gravelly silt loam	ML	A–4
				40–60	Very gravelly sand	GP	A–1

See footnotes at end of table.

properties of the soils

estimating and require onsite investigation. An asterisk in the first column indicates that at least one mapping unit in this series is made up necessary to follow carefully the instructions for referring to other series that appear in the first column of this table]

Percentage passing sieve—				Liquid limit	Plasticity index	Perme-ability	Available water capacity	Reaction	Corrosivity for untreated steel pipe	Shrink-swell potential
No. 4 [1] (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)			*In./hr.*	*In./in. of soil*	*pH*		
100	100	95–100	80–85	35–40	11–15	0. 63–2. 0	0. 19–0. 21	5. 6–6. 0	Moderate	Moderate.
94–100	95–100	95–100	85–95	41–50	11–25	0. 20–0. 63	0. 15–0. 17	5. 1–5. 5	High	High.
100	100	95–100	80–90	35–40	11–15	0. 63–2. 0	0. 19–0. 21	5. 1–5. 5	High	Moderate.
100	100	95–100	90–95	30–40	5–10	0. 63–2. 0	0. 19–0. 21	5. 6–6. 0	High	Moderate.
100	100	95–100	95–100	41–50	11–20	0. 20–0. 63	0. 19–0. 21	6. 1–6. 5	High	Moderate.
100	100	95–100	90–95	30–40	5–10	0. 63–2. 0	0. 19–0. 21	6. 1–6. 5	High	Moderate.
100	100	95–100	85–95	70–90	40–60	<0. 06	0. 14–0. 16	5. 6–7. 3	High	High.
60–85	50–80	30–50	15–25	[2] NP	[2] NP	>20. 0	0. 07–0. 09	5. 6–6. 5	Low	Low.
40–60	40–50	20–30	0–5	[2] NP	[2] NP	>20. 0	0. 03–0. 05	5. 6–6. 5	Low	Low.
100	95–100	90–95	80–95	30–40	5–10	0. 63–2. 0	0. 19–0. 21	5. 6–6. 0	High	Moderate.
100	100	90–95	85–95	50–60	11–20	0. 06–0. 2	0. 15–0. 17	5. 6–6. 0	High	High.
100	100	95–100	85–95	35–40	11–15	0. 63–2. 0	0. 19–0. 21	6. 1–6. 6	Moderate	Moderate.
100	95–100	85–95	80–85	30–40	5–10	0. 63–2. 0	0. 19–0. 21	5. 6–6. 0	Low	Low.
75–90	70–85	60–80	40–50	35–40	11–15	0. 63–2. 0	0. 10–0. 12	5. 6–6. 0	High	Low.
60–75	60–70	45–65	40–50	41–50	11–20	0. 20–0. 63	0. 14–0. 16	5. 6–6. 0	High	Low.
15–30	10–20	5–20	5–15	41–50	11–20	0. 20–0. 63	0. 03–0. 05	5. 1–5. 5	High	Low.
100	100	95–100	80–90	34–40	5–15	0. 63–2. 0	[4] 0. 20–0. 23	5. 6–6. 5	Low	Low.
100	100	95–100	40–50	[2] NP	[2] NP	0. 63–2. 0	0. 13–0. 15	6. 1–6. 5	Low	Low.
100	100	95–100	85–95	30–40	5–10	0. 63–2. 0	0. 19–0. 21	5. 6–6. 0	High	Low.
100	100	95–100	80–90	41–50	11–20	0. 06–0. 2	0. 15–0. 17	6. 1–7. 3	High	High.
100	100	95–100	80–90	[2] NP	[2] NP	0. 20–0. 63	0. 19–0. 21	6. 1–7. 3	High	Low.
80–85	70–80	70–80	65–75	30–40	5–10	0. 20–0. 63	0. 16–0. 18	5. 1–6. 0	High	Moderate.
75–85	70–80	60–80	50–75	60–80	41–50	<0. 06	0. 10–0. 14	6. 1–6. 5	High	High.
25–60	15–50	10–50	10–35	25–40	2–10	0. 20–0. 63	0. 06–0. 12	6. 1–7. 3	High	Low.
100	90–95	85–95	70–90	35–40	11–15	0. 20–0. 63	0. 19–0. 21	5. 6–6. 5	High	Moderate.
100	100	90–95	60–90	50–60	11–25	0. 20–0. 63	0. 14–0. 16	5. 1–6. 0	High	High.
100	100	95–100	90–100	30–40	5–10	0. 20–0. 63	[4] 0. 23–0. 25	5. 6–6. 0	High	Low.
100	100	95–100	90–100	60–80	41–50	<0. 06	0. 03–0. 05	6. 1–6. 5	High	High.
100	100	95–100	90–100	25–40	2–10	0. 20–0. 63	0. 20–0. 23	6. 1–6. 5	High	Moderate.
95–100	90–95	85–95	80–90	30–40	11–20	0. 63–2. 0	[4] 0. 16–0. 18	5. 6–6. 5	High	Moderate.
95–100	85–95	75–85	70–85	60–80	40–50	0. 06–0. 2	0. 13–0. 16	6. 1–6. 5	High	High.
25–55	20–50	10–25	10–15	[2] NP	[2] NP	2. 00–6. 3	0. 05–0. 08	6. 1–6. 5	Low	Low.
100	95–100	90–95	90–95	30–40	5–10	0. 63–2. 0	0. 19–0. 21	5. 6–6. 5	High	Moderate.
100	100	95–100	95–100	60–80	41–50	<0. 06	0. 03–0. 05	6. 1–7. 3	High	High.
90–100	85–100	65–95	50–75	25–40	2–10	0. 63–2. 0	0. 16–0. 18	5. 1–5. 5	Moderate	Low.
75–85	70–80	60–75	45–60	25–40	2–10	0. 63–2. 0	0. 12–0. 14	4. 5–5. 0	Moderate	Low.
30–80	25–75	20–70	15–60	25–40	2–10	0. 63–2. 0	0. 06–0. 12	4. 5–5. 0	Moderate	Low.
75–85	70–80	65–75	50–60	25–40	5–10	0. 63–2. 0	0. 15–0. 17	5. 1–5. 5	Low	Low.
30–55	25–50	10–35	0–5	[2] NP	[2] NP	>20. 0	0. 03–0. 05	4. 5–5. 0	Low	Low.

TABLE 4.—*Estimated engineering*

Soil series and map symbols	Hydrologic group	Depth to bedrock	Depth to seasonal high water table	Depth from surface	Classification		
					USDA texture	Unified	AASHO
		In.	*In.*	*In.*			
Hullt (HTD, HTE, HTF, HuB, HuD).	B	40–60	(3)	0–55	Clay loam and silty clay loam	CL	A–6
				55	Weathered sandstone.		
Jory (JoB, JoC, JoD, JoE)	C	60+	(3)	0–63	Silty clay loam, silty clay, and clay.	ML or CL	A–7
Kinney (KCD, KCF, KCG)	B	40–60	(3)	0–53	Cobbly loam, cobbly clay loam.	SM	A–5
				53	Weathered agglomerate.		
Labish (La)	D	72+	0–16	0–60	Silty clay and clay	OH	A–7
McAlpin (MaA, MaB)	C	60+	16–30	0–14	Silty clay loam	ML or CL	A–6
				14–65	Silty clay, silty clay loam	ML or CL	A–7
McBee (Mb)	B	72+	24–30	0–65	Silty clay loam and clay loam.	CL or ML	A–6
McCully (McB, McC, McD, McE, MID, MmE, MUE, MUF, MUG).	C	40+	(3)	0–10	Clay loam	MH	A–5
				10–57	Clay	ML or MH	A–5
Minniece (MYB)	D	60+	0–6	0–15	Silty clay loam	ML or CL	A–6
				15–60	Clay	MH	A–7
Nekia (NeB, NeC, NeD, NeE, NeF, NkC, NsE, NsF).	C	20–40	(3)	0–18	Silty clay loam, clay	ML or CL	A–6
				18–36	Clay	ML or GC	A–5
				36	Weathered rock.		
Newberg (Nu, Nw)	B	72+	60+	0–60	Fine sandy loam, sandy loam.	SM	A–4 or A–2
Salem (Sa)	B	72+	72+	0–30	Gravelly silt loam, gravelly silty clay loam.	ML, SM or GM	A–7
				30–60	Very gravelly sand	GP	A–1
Salkum (SkB, SkD, SlB)	C	72+	(3)	0–14	Silty clay loam.	ML or CL	A–6
				14–40	Silty clay	CH	A–7
				40–65	Silty clay loam, gravelly and cobbly clay loam.[5]	ML or CL	A–6
Santiam (SnA, SnB, SnC)	C	40+	6–24	0–13	Silt loam	ML	A–4
				13–30	Heavy silty clay loam	ML or CL	A–6
				30–60	Silty clay and clay	CH	A–7
Semiahmoo (So)	D	72+	0–14	0–30	Muck	Pt	----------
				30–60	Peat	Pt	----------
Sifton (St)	B	72+	60+	0–24	Gravelly loam	SM or GM	A–4
				24–60	Very gravelly and cobbly sand.	GP	A–1
Silverton (SuC, SuD)	C	20–40	(3)	0–16	Silt loam	ML	A–4
				16–37	Silty clay loam, gravelly silty clay.	CL or GC	A–7
				37	Weathered basalt.		
Stayton (SvB)	D	15–20	(3)	0–20	Silt loam	ML	A–4
				20	Hard basalt.		
*Steiwer (SCE, SwB, SwD) (For Chehulpum part of SCE, see Chehulpum series.)	C	20–40	(3)	0–21	Silt loam	ML	A–4
				21–32	Silty clay loam	ML or CL	A–7 or A–6
				32	Hard sandstone.		

See footnotes at end of table.

properties of the soils—Continued

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Corrosivity for untreated steel pipe	Shrink-swell potential
No. 4 [1] (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)							
						In./hr.	*In./in. of soil*	*pH*		
100	85–95	75–95	65–75	30–40	11–20	0.20–0.63	0.19–0.21	4.5–6.0	Moderate	Moderate.
100	100	80–95	65–90	41–50	15–20	0.20–0.63	0.15–0.17	4.5–6.0	High	Moderate.
55–80	50–75	40–60	35–50	45–65	3–10	0.63–2.0	0.13–0.16	4.5–5.5	High	Low.
100	100	95–100	85–95	50–60	11–25	0.06–0.2	0.20–0.25	4.5–7.3	High	High.
100	100	85–95	75–90	35–40	11–15	0.63–0.2	0.19–0.21	5.1–6.0	High	Moderate.
100	100	95–100	90–95	41–50	11–20	0.20–0.63	0.15–0.17	5.1–6.0	High	High.
100	100	95–100	85–95	35–40	11–15	0.63–0.2	0.19–0.21	5.6–6.5	High	Moderate.
100	85–100	65–75	50–60	51–55	5–10	0.63–0.2	0.17–0.21	5.1–5.5	High	Low.
90–100	85–100	80–95	60–70	45–55	5–10	0.20–0.63	0.14–0.16	4.5–5.0	High	Moderate.
100	95–100	95–100	85–95	35–40	11–15	0.20–0.63	0.19–0.21	5.6–6.0	High	Moderate.
100	100	95–100	75–95	51–60	15–25	<0.06	0.06–0.08	5.6–6.0	High	High.
100	85–100	85–95	70–80	35–40	11–15	0.20–0.63	0.17–0.21	5.1–6.0	High	Low.
70–100	50–100	50–90	40–75	41–45	5–10	0.20–0.63	0.09–0.16	5.1–5.5	High	Moderate.
100	100	60–70	30–40	[2]NP	[2]NP	2.0–6.3	0.11–0.13	5.6–7.3	Low	Low.
55–95	50–90	45–80	40–70	41–50	11–20	0.63–2.0	0.12–0.17	6.1–7.3	Moderate	Low to moderate.
20–65	15–65	5–15	0–5	[2]NP	[2]NP	>20.0	0.03–0.05	6.1–6.5	Low	Low.
85–95	90–95	80–90	70–80	30–40	11–15	0.20–0.63	0.18–0.20	4.5–5.5	High	Low.
85–95	90–95	80–90	70–80	41–50	15–20	0.20–0.63	0.15–0.17	4.5–5.5	High	Moderate.
85–95	90–95	80–90	70–80	30–40	11–15	0.06–0.20	0.15–0.17	4.5–5.0	High	Low.
100	100	80–90	70–80	30–40	5–10	0.63–2.0	0.19–0.21	5.6–6.0	High	Low.
100	100	85–95	75–85	30–40	11–15	0.20–0.63	0.17–0.19	5.1–6.0	High	Moderate.
100	95–100	80–90	70–80	50–60	30–40	0.06–0.2	0.14–0.16	5.1–5.5	High	High.
---	---	---	---	---	---	0.63–2.0	0.20–0.50	5.6–6.5	High	High shrink; low swell.
---	---	---	---	---	---	0.63–2.0	0.25–0.50	6.1–6.5	High	High shrink; low swell.
65–80	60–75	50–60	35–50	[2] NP	[2] NP	2.0–6.3	0.12–0.14	6.1–7.3	Low	Low.
35–45	30–40	10–20	0–5	[2] NP	[2] NP	>20.0	0.03–0.05	5.6–6.0	Low	Low.
100	100	80–90	70–80	30–40	5–10	0.63–2.0	0.19–0.21	5.6–6.0	Low	Low.
55–90	50–85	40–70	35–60	41–50	15–20	0.20–0.63	0.13–0.15	5.6–6.0	High	Moderate to high.
100	100	85–95	80–90	30–40	5–10	0.63–2.0	0.18–0.21	5.6–6.0	Low	Low.
100	95–100	85–95	75–85	30–40	5–10	0.63–2.0	0.19–0.21	5.1–6.0	High	Moderate.
100	95–100	85–95	80–90	30–45	5–15	0.20–0.63	0.19–0.21	5.1–6.5	High	Moderate.

TABLE 4.—*Estimated engineering*

Soil series and map symbols	Hydrologic group	Depth to bedrock	Depth to seasonal high water table	Depth from surface	Classification		
					USDA texture	Unified	AASHO
		In.	*In.*	*In.*			
Waldo (Wa)	D	60+	0–6	0–10	Silty clay loam	ML or CL	A–6
				10–60	Clay and silty clay	MH	A–7
Wapato (Wc)	D	72+	0–6	0–60	Silty clay loam	ML or CL	A–6
Whetstone (WHE, WHF, WHG)	B	20–40	(3)	0–38	Stony loam	GM	A–4 or A–2
				38	Basalt.		
Willamette (WlA, WlC)	B	72+	72+	0–24	Silt loam	ML	A–4
				24–54	Silty clay loam, silt loam	ML or CL	A–7
				54–65	Silt loam	ML or CL	A–6
Witzel (WtE)	D	12–20	(3)	0–19	Very stony silty clay loam	GC or CL	A–6 or A–2
				19	Basalt.		
Woodburn (WuA, WuC, WuD)	C	72+	30+	0–17	Silt loam	ML	A–4
				17–32	Silty clay loam	ML or CL	A–4
				32–68	Silt loam	ML or CL	A–6

[1] Includes material larger than 3 inches in diameter.
[2] NP=Nonplastic.
[3] Water table is not a restricting factor.

TABLE 5.—*Engineering interpretations*

[Alluvial land (Ad), Stony rock land (Sy), and Terrace escarpments (Te) are omitted from table because their properties are too variable made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Trafficability (off road for heavy equipment)	Winter grading
Abiqua (AbA, AbB)	Good to a depth of 21 inches.	Not suitable: thick overburden.	Not suitable: thick overburden.	Poor: subsoil is plastic and has high shrink-swell potential; A–6 and A–7 material.	Moderately slow permeability; high shrink-swell potential; plastic; high frost-heave potential.	Low shear strength; low to moderate bearing capacity; moderately slow permeability.	Plastic when wet; difficult to excavate.
Amity (Am)	Good	Not suitable: thick overburden.	Not suitable: thick overburden.	Fair to poor: subsoil is plastic and has moderate shrink-swell potential; A–4 and A–7 material.	Seasonal high water table in winter and spring; moderately slow permeability; moderate shrink-swell potential.	Wet in winter and spring; low shear strength and bearing capacity; moderately slow permeability.	Water table at depth of 6 to 12 inches; somewhat poorly drained; slightly difficult to excavate; plastic where wet.

properties of the soils—Continued

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Corrosivity for untreated steel pipe	Shrink-swell potential
No. 4[1] (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)							
						In./hr.	*In./in. of soil*	*pH*		
100	100	95–100	85–95	35–40	11–15	0. 20–0. 63	0. 19–0. 21	5. 6–6. 0	High	Moderate.
100	100	90–95	80–90	51–60	15–25	0. 06–0. 2	0. 14–0. 17	5. 6–6. 5	High	High.
100	100	95–100	80–90	35–40	11–15	0. 20–0. 63	0. 19–0. 21	6. 1–6. 5	High	Moderate.
55–80	50–75	40–60	30–50	30–40	5–10	0. 63–2. 0	0. 12–0. 14	4. 0–5. 5	High	Low.
95–100	95–100	95–100	95–100	35–40	5–10	0. 63–2. 0	0. 19–0. 21	5. 6–6. 5	Moderate	Low.
100	100	95–100	95–100	41–50	15–25	0. 63–2. 0	0. 19–0. 21	6. 1–6. 5	Moderate	Moderate.
100	100	100	95–100	35–40	11–15	0. 63–2. 0	0. 19–0. 21	6. 1–6. 5	Low	Low.
30–80	25–75	20–65	20–60	35–40	15–20	0. 20–0. 63	0. 08–0. 10	5. 6–6. 0	Moderate	Low.
95–100	90–95	85–95	70–80	25–30	2–5	0. 63–2. 0	0. 19–0. 21	5. 6–6. 5	Moderate	Low.
100	100	95–100	70–80	25–35	5–10	0. 63–2. 0	0. 19–0. 21	5. 6–6. 0	High	Moderate.
100	100	95–100	80–90	30–40	11–15	0. 06–0. 2	0. 19–0. 21	5. 6–6. 0	High	Low.

[4] Values were obtained by multiplying the bulk density by the difference in moisture held at tension of ⅓ atmosphere and at 15 atmospheres.
[5] Gravel and cobblestones are highly weathered.

for specified uses

for rating and require onsite investigation. An asterisk in the first column indicates that at least one mapping unit in this series is it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table]

Soil features affecting—Continued							
Foundations for low buildings	Dikes	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
		Reservoir area	Embankment				
Low shear strength; high shrink-swell potential; medium compressibility; moderately slow permeability.	Low to moderate stability; semipervious to impervious where compacted; high shrink-swell potential.	Moderately slow permeability; in some places gravel is at depths below 40 inches.	Low shear strength; semipervious to impervious where compacted; low to moderate stability; high shrink-swell potential; medium compressibility.	Moderately slow permeability; ditchbanks stable; high corrosion potential.	Moderate intake rate; high available water capacity.	Moderately slow permeability.	High available water capacity; vegetation fairly easy to establish.
Low shear strength; moderate shrink-swell potential; medium compressibility; moderately slow permeability; seasonal high water table at depth of 6 to 12 inches.	Low stability; semipervious to impervious where compacted; moderate shrink-swell potential; cracks where dry.	Moderately slow permeability; seasonal high water table.	Low shear strength and stability; semipervious to impervious when compacted; medium compressibility; moderate shrink-swell potential.	Natural drainageways inadequate; seasonal high water table; moderately slow permeability.	High available water capacity; moderate intake rate.	Not applicable.	High available water capacity; vegetation easy to establish.

TABLE 5.—*Engineering interpretations*

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Trafficability (off road for heavy equipment)	Winter grading
Bashaw (Ba)	Poor to not suitable: thick clay.	Not suitable: thick clay overburden.	Not suitable: thick clay overburden.	Poor: very plastic; high shrink-swell potential; A–7 material.	Very slow permeability; high shrink-swell potential; seasonal high water table.	Low shear strength; high bearing capacity; very slow permeability; seasonal high water table.	High water table; poor drainage; difficult to excavate; very plastic where wet.
Camas (Ca)	Not suitable: excessive gravel.	Poor: excessive gravel.	Good	Good: nonplastic; low shrink-swell potential; A–1 material	Very rapid permeability; low shrink-swell potential; subject to overflow.	High shear strength and bearing capacity; very rapid permeability.	Nonplastic; easy to excavate; subject to overflow.
Chehalem (CeC)	Good	Not suitable: thick overburden.	Not suitable: thick overburden.	Fair to poor: high shrink-swell potential; plastic; very low shear strength; seasonal high water table at depth of 6 to 16 inches; A–4 to A–7 material.	Slow permeability; high shrink-swell potential; seasonal high water table; unstable in cuts and ditches; plastic.	Low shear strength; low to moderate bearing capacity; slow permeability; seasonal high water table at depth of 6 to 16 inches.	Poor trafficability; water table at depth of 6 to 16 inches; plastic when wet; difficult to excavate.
Chehalis (Ch)	Good	Not suitable: thick overburden.	Not suitable: thick overburden.	Poor: plastic when wet; very low shear strength; A–6 material.	Moderate permeability and shrink-swell potential; poor stability; plastic.	Very low shear strength; low to moderate bearing capacity; moderate permeability.	Poor trafficability; plastic when wet and difficult to excavate.
Chehulpum (Mapped only in an undifferentiated unit with Steiwer soils.)	Good	Not suitable.	Not suitable.	Fair: low stability; A–4 material.	Moderate permeability; low shrink-swell potential; low stability.	Very low shear strength; low bearing capacity; moderate permeability.	Poor trafficability; 3 to 40 percent slopes.

for specified uses—Continued

Soil features affecting—Continued							
Foundations for low buildings	Dikes	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
		Reservoir area	Embankment				
Low shear strength; very high compressibility; very slow permeability; seasonal high water table.	Moderate stability; impervious where compacted; high shrink-swell potential; cracks where dry.	Very slow permeability; seasonal high water table.	Low shear strength; impervious where compacted; very high compressibility; moderate stability; cracks where dry.	Very slow permeability; ditchbanks unstable; seasonal high water table.	Slow intake rate; moderate to high available water capacity.	Not applicable.	High to moderate available water capacity; vegetation difficult to establish; dense clay.
Subject to overflow.	High stability; very pervious where compacted; low shrink-swell potential.	Very rapid permeability; gravel is below surface layer.	High shear strength; very pervious where compacted; very slight compressibility; high stability; low shrink-swell potential.	Subject to overflow.	Very rapid intake rate; very low available water capacity; low fertility; subject to overflow.	Not applicable.	Very low available water capacity; vegetation difficult to establish.
Very low shear strength; high shrink-swell potential; water table at depth of 6 to 16 inches; slow permeability.	Low stability; semipervious to impervious where compacted; high shrink-swell potential; cracks when dry.	Slow permeability; seasonal high water table at depth of 6 to 16 inches; weathered sedimentary rock below solum.	Very low shear strength; semipervious to impervious where compacted; medium to high compressibility; low stability; high shrink-swell potential.	Slow permeability; seasonal high water table at depth of 6 to 16 inches; unstable ditchbanks; seepage.	High available water capacity; moderate intake rate; water table at depth of 6 to 16 inches; 2 to 12 percent slopes	Slow permeability.	High available water capacity; vegetation fairly easy to establish.
Very low shear strength; moderate shrink-swell potential; medium to high compressibility; poor resistance to piping.	Low stability; semipervious to impervious where compacted; moderate shrink-swell potential; cracks when dry.	Moderate permeability; strata of sand or gravel can occur at depth of 40 inches or more.	Very low shear strength; semipervious to impervious where compacted; medium to high compressibility; low stability; moderate shrink-swell potential.	Well drained__	Very high available water capacity; moderate intake rate.	Not applicable.	High available water capacity; vegetation easy to establish.
Very low shear strength; low shrink-swell potential; medium to high compressibility; bedrock at depth of 10 to 20 inches.	Low stability; low shrink-swell potential; semipervious to impervious where compacted.	Moderate permeability; bedrock at depth of 10 to 20 inches.	Very low shear strength; semipervious to impervious where compacted; medium to high compressibility; low stability.	Moderate permeability.	Moderate intake rate; very low available water capacity.	Bedrock at depth of 10 to 20 inches.	Very low available water capacity; vegetation fairly difficult to establish; bedrock at depth of 10 to 20 inches.

TABLE 5.—*Engineering interpretations*

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Trafficability (off road for heavy equipment)	Winter grading
Clackamas (Ck)	Poor to not suitable: too much gravel.	Poor to not suitable: too much gravel and fine material.	Good	Poor to fair: moderate shear strength; A–6 and A–7 material.	Moderately slow permeability; low shrink-swell potential; seasonal high water table.	Moderate shear strength; high bearing capacity; moderately slow permeability.	Good trafficability; water table at depth of 6 to 16 inches.
Cloquato (Cm)	Good	Not suitable: thick overburden.	Not suitable: thick overburden.	Fair: very low shear strength; A–4 material.	Moderate permeability; low shrink-swell potential; low stability.	Very low shear strength; low bearing capacity; moderate permeability.	Poor trafficability; difficult to excavate; subject to overflow.
Concord (Co)	Fair to good: silty clay subsoil.	Not suitable: thick overburden.	Not suitable: thick overburden.	Poor to fair: very low shear strength; A–4 to A–7 material.	Slow permeability; high shrink-swell potential; seasonal high water table; low to moderate stability; plastic.	Very low shear strength; low to moderate bearing capacity; slow permeability.	Poor trafficability; seasonal water table 6 inches or less below surface; plastic when wet and difficult to excavate.
Courtney (Cu)	Poor	Poor to not suitable: excessive gravel and fine material.	Good	Good to poor: moderate shear strength; A–2 to A–7 material.	Very slow permeability; high shrink-swell potential; high stability.	Moderate shear strength; high bearing capacity; very slow permeability.	Fair trafficability; seasonal high water table 6 inches or less below surface; plastic when wet and difficult to excavate.

for specified uses—Continued

Soil features affecting—Continued							
Foundations for low buildings	Dikes	Farm ponds: Reservoir area	Farm ponds: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Moderate shear strength; low shrink-swell potential; slight compressibility; moderately slow permeability.	High stability; semipervious to impervious where compacted; low shrink-swell potential; poor resistance to piping.	Moderately slow permeability; water table at depth of 6 to 16 inches; compact gravel at depth of 40 inches or more.	Moderate shear strength; semipervious to impervious where compacted; slight compressibility; high stability.	Moderately slow permeability; seasonal high water table; stable ditchbanks.	Moderate intake rate; low available water capacity; somewhat poor drainage.	Not applicable.	Low available water capacity; vegetation fairly difficult to establish.
Very low shear strength; low shrink-swell potential; medium compressibility; moderate permeability.	Low stability; low shrink-swell potential; semipervious to impervious where compacted; poor resistance to piping.	Moderate permeability; strata of sand or gravel can occur at depths of 40 inches or more.	Very low shear strength; semipervious to impervious where compacted; medium compressibility; low stability; low shrink-swell potential; poor resistance to piping.	Well drained	Moderate intake rate; high available water capacity.	Not applicable.	High available water capacity; vegetation easy to establish.
Very low shear strength; high shrink-swell potential; medium compressibility; seasonal high water table.	Low to moderate stability; semipervious to impervious where compacted; high shrink-swell potential.	Slow permeability; seasonal high water table 6 inches or less below surface.	Very low shear strength; impervious to semipervious where compacted; medium compressibility; moderate to low stability; high shrink-swell potential; good to poor resistance to piping.	Slow permeability; seasonal high water table.	Moderate intake rate; high available water capacity; seasonal high water table 6 inches or less below surface; clay at depth of about 19 inches limits root zone.	Not applicable.	High available water capacity; vegetation fairly easy to establish.
Moderate shear strength; high shrink-swell potential; high water table; slight compressibility.	High stability; high shrink-swell potential; impervious where compacted.	Very slow permeability; seasonal high water table 6 inches or less below surface.	Moderate shear strength; impervious where compacted; high stability; slight compressibility; good resistance to piping.	Very slow permeability; seasonal high water table.	Moderate intake rate; very low available water capacity; seasonal high water table 6 inches or less below surface; clay at depth of 12 to 18 inches limits root zone.	Not applicable.	Very low available water capacity; vegetation difficult to establish.

TABLE 5.—*Engineering interpretations*

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Trafficability (off road for heavy equipment)	Winter grading
Cumley (CLD)	Fair: thin silty clay loam surface layer.	Not suitable: thick overburden.	Not suitable: thick overburden.	Poor: low shear strength; A–6 and A–7 material.	Moderately slow permeability; high shrink-swell potential; slight to severe frost hazard; seepage; low stability.	Low shear strength; low to moderate bearing capacity; moderately slow permeability; seepage.	Poor trafficability; plastic when wet and difficult to excavate.
Dayton (Da)	Fair: clay at depth of 12 to 24 inches.	Not suitable: thick overburden.	Not suitable: thick overburden.	Fair to poor: very low shear strength; seasonal water table 6 inches or less below surface; A–4 and A–7 material.	Very slow permeability; high shrink-swell potential; seasonal high water table; low stability; very plastic.	Very low shear strength; low bearing capacity; very slow permeability; seasonal high water table.	Poor trafficability; plastic when wet and difficult to excavate; seasonal high water table.
Hazelair (HaB, HaD, HcD2).	Fair: clay at depth of 12 to 24 inches.	Not suitable: clay subsoil and sedimentary rock substratum.	Not suitable: clay subsoil and sedimentary rock substratum.	Poor: very low shear strength; A–6 and A–7 material.	Slow permeability; high shrink-swell potential; seepage; low stability; very plastic.	Very low shear strength; low bearing capacity; slow permeability; seepage.	Poor trafficability; perched water table; plastic when wet and difficult to excavate.
Henline (HEE, HEF, HEG).	Not suitable: very stony to bedrock of basalt.	Poor: excessive stones and fine material over bedrock of basalt.	Poor: possible source of basalt for crushing.	Good: moderate shear strength.	Moderately rapid permeability; low shrink-swell potential; slight to moderate susceptibility to frost heave.	Moderate shear strength; high bearing capacity; moderately rapid permeability.	Poor trafficability; very stony; 6 to 80 percent slopes.
Holcomb (Ho)	Fair: excessive fine material at depth of 12 to 24 inches.	Not suitable: too much fine material.	Not suitable: thick over burden.	Fair to poor: very low shear strength; A–4 and A–7 material.	Very slow permeability; high shrink-swell potential; seasonal high water table; low to moderate stability; very plastic subsoil.	Very low shear strength; low bearing capacity; very slow permeability; seasonal high water table.	Poor trafficability; high water table; difficult to excavate.

for specified uses—Continued

Soil features affecting—Continued							
Foundations for low buildings	Dikes	Farm ponds: Reservoir area	Farm ponds: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Low shear strength; high shrink-swell potential; high compressibility; water table at depth of 18 to 48 inches.	Low stability; semipervious to impervious where compacted; high shrink-swell potential.	Moderately slow permeability; seasonal water table at depth of 18 to 48 inches.	Low shear strength; low stability; semipervious to impervious where compacted; slight to medium compressibility.	Moderately slow permeability; seepage.	Moderate intake rate; high available water capacity.	Moderately slow permeability.	Vegetation fairly easy to establish.
Very low shear strength; high shrink-swell potential; high compressibility; seasonal high water table; very slow permeability.	Low stability; semipervious to impervious where compacted; high shrink-swell potential; cracks when dry.	Very slow permeability; seasonal water table 6 inches or less below surface.	Very low shear strength; semipervious to impervious where compacted; medium to high compressibility; low stability; cracks when dry; good resistance to piping.	Very slow permeability; seasonal high water table.	Slow intake rate; low available water capacity; clay at depth of 12 to 24 inches limits root zone; seasonal high water table.	Not applicable.	Low available water capacity; vegetation fairly difficult to establish.
Very low shear strength; high shrink-swell potential; perched water table; very high compressibility.	Low stability; semipervious to impervious where compacted; high shrink-swell potential.	Slow permeability; perched water table.	Very low shear strength; semipervious to impervious where compacted; medium to very high compressibility; low stability; cracks when dry.	Slow permeability; perched water table; 2 to 20 percent slopes; seepage.	Moderate intake rate; low available water capacity; 2 to 20 percent slopes; perched water table.	Slow permeability.	Low available water capacity; vegetation fairly difficult to establish.
Moderate shear strength; low shrink-swell potential; very slight compressibility; 6 to 80 percent slopes.	High stability; semipervious where compacted; low shrink-swell potential; poor resistance to piping.	Moderately rapid permeability.	Moderate shear strength; semipervious where compacted; very slight compressibility; high stability; poor resistance to piping.	Moderately rapid permeability; well drained.	Rapid intake rate; low available water capacity.	Not applicable.	Low available water capacity; vegetation difficult to establish.
Very low shear strength; high shrink-swell potential; medium to high compressibility; high water table.	Low to moderate stability; semipervious to impervious where compacted; high shrink-swell potential; subsoil has good resistance to piping.	Very slow permeability; seasonal high water table.	Very low shear strength; semipervious to impervious where compacted; medium to high compressibility; low to moderate stability.	Very slow permeability; seasonal high water table.	Slow intake rate; low available water capacity; high water table.	Not applicable.	Low available water capacity; vegetation fairly easy to establish.

TABLE 5.—*Engineering interpretations*

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Trafficability (off road for heavy equipment)	Winter grading
Horeb: (HRD)	Fair: excessive gravel at depth below 14 inches.	Not suitable: excessive fine material.	Poor to not suitable: excessive fine material.	Fair: moderate shear strength; A–4 material.	High susceptibility to frost heave; moderate permeability; low shrink-swell potential; low stability; seepage.	Moderate shear strength; high bearing capacity; moderate permeability; seepage.	Fair trafficability; seepage.
(HSC, HSE)	Fair: excessive gravel in surface layer.	Poor: excessive gravel.	Fair: gravelly sand at depth below about 40 inches.	Good to fair: low shear strength; A–1 and A–4 material.	High susceptibility to frost heave; moderate permeability; low shrink-swell potential; low stability; seepage.	Moderate shear strength; high bearing capacity; moderate permeability; seepage.	Fair trafficability; seepage.
Hullt (HuB, HuD, HTD, HTE, HTF).	Fair to good: clay loam surface layer.	Not suitable: excessive fine material over sandstone.	Not suitable: excessive fine material over sandstone.	Poor: low shear strength; A–6 material.	Moderately slow permeability; moderate shrink-swell potential; low stability.	Low shear strength; moderate to high bearing capacity; moderately slow permeability.	Poor trafficability; plastic when wet and difficult to excavate.
Jory (JoB, JoC, JoD, JoE).	Fair: excessive fine material.	Not suitable: excessive fine material over bedrock.	Not suitable: excessive fine material over bedrock.	Poor: A–7 material.	Moderately slow permeability; moderate stability; moderate shrink-swell potential.	Very low shear strength; moderate bearing capacity; moderately slow permeability.	Poor trafficability; plastic when wet and difficult to excavate.

for specified uses—Continued

Soil features affecting—Continued							
Foundations for low buildings	Dikes	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
		Reservoir area	Embankment				
Moderate shear strength; low shrink-swell potential; slight compressibility; 2 to 20 percent slopes.	Low shrink-swell potential; low stability; semipervious to impervious where compacted; surface layer has poor resistance to piping, but subsoil has good resistance.	Moderate permeability.	Moderate shear strength; semipervious to impervious where compacted; very slight compressibility; low stability; surface layer has poor resistance to piping, but subsoil has good resistance.	Moderate permeability.	Rapid to moderate intake rate; moderate available water capacity.	Moderate permeability.	Moderate available water capacity; vegetation fairly easy to establish.
Moderate shear strength; low shrink-swell potential; slight compressibility; 2 to 20 percent slopes.	Low shrink-swell potential; low stability; semipervious to impervious where compacted; surface layer has poor resistance to piping, but subsoil has good resistance.	Moderate permeability; porous gravel at depth of 40 inches.	Moderate shear strength; semipervious to impervious where compacted; very slight compressibility; low stability; surface layer has poor resistance to piping, but subsoil has good resistance.	Moderate permeability.	Rapid to moderate intake rate; moderate available water capacity.	Moderate permeability.	Moderate available water capacity; vegetation fairly easy to establish.
Low shear strength; moderate shrink-swell potential; medium compressibility; 2 to 60 percent slopes.	Low stability; semipervious to impervious where compacted; moderate shrink-swell potential.	Moderately slow permeability; 2 to 60 percent slopes.	Low shear strength; low stability; semipervious to impervious where compacted; medium compressibility; good to poor resistance to piping.	Moderately slow permeability; well drained.	Moderate intake rate; high available water capacity; 2 to 60 percent slopes.	Moderately slow permeability.	High available water capacity; vegetation easy to establish.
Very low shear strength; moderate shrink-swell potential; 2 to 30 percent slopes.	Moderate stability and shrink-swell potential; semipervious where compacted.	Moderately slow permeability; 2 to 30 percent slopes.	Very low shear strength; semipervious where compacted; medium compressibility; poor to good resistance to piping; moderate stability.	Moderately slow permeability; well drained.	Moderate intake rate; high available water capacity; 2 to 30 percent slopes.	Moderately slow permeability.	High available water capacity; vegetation fairly easy to establish.

TABLE 5.—*Engineering interpretations*

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Trafficability (off road for heavy equipment)	Winter grading
Kinney (KCD, KCF, KCG).	Not suitable: cobbly surface layer.	Not suitable: excessive fine material.	Not suitable: excessive fine material over weathered agglomerate.	Fair: low shear strength.	Moderate susceptibility to frost heave; moderate permeability; low stability; low shrink-swell potential.	Low shear strength; high bearing capacity; moderate permeability.	Poor trafficability.
Labish (La)	Fair: excessive fine material.	Not suitable: excessive fine material.	Not suitable: excessive fine material.	Poor: high shrink-swell potential; A–7 material.	Slow permeability; high shrink-swell potential; seasonal high water table.	Very low shear strength; moderate bearing capacity; slow permeability; seasonal high water table.	Poor trafficability; plastic when wet and difficult to excavate; seasonal high water table.
McAlpin (MaA, MaB).	Good	Not suitable: thick overburden.	Not suitable: thick overburden.	Poor: very low shear strength; A–6 and A–7 material.	Moderately slow permeability; high shrink-swell potential; seasonal high water table; low stability.	Very low shear strength; low to moderate bearing capacity; moderately slow permeability; seasonal high water table.	Poor trafficability; water table at depth of 16 to 30 inches; plastic when wet and difficult to excavate.
McBee (Mb)	Good	Not suitable: thick overburden.	Not suitable: thick overburden.	Poor: very low shear strength; A–6 material.	Moderate permeability and shrink-swell potential; seasonal high water table; low stability; flood hazard.	Very low shear strength; low to moderate bearing capacity; moderate permeability; seasonal high water table; flood hazard.	Poor trafficability; water table at depth of 24 to 30 inches; plastic when wet and difficult to excavate.
McCully (McB, McC, McD, McE, MlD, MmE, MUE, MUF, MUG).	Fair: excessive fine material.	Not suitable: excessive clay.	Not suitable: thick overburden over agglomerate.	Fair: very low shear strength; A–5 material.	Moderately slow permeability; moderate shrink-swell potential; low stability.	Very low shear strength; low bearing capacity; moderately slow permeability.	Poor trafficability; plastic when wet and difficult to excavate.

for specified uses—Continued

Soil features affecting—Continued							
Foundations for low buildings	Dikes	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
		Reservoir area	Embankment				
Low shear strength; low shrink-swell potential; 2 to 70 percent slopes.	Low stability and shrink-swell potential; semipervious where compacted; poor resistance to piping.	Moderate permeability.	Low stability; low shear strength; semipervious where compacted; very slight compressibility; poor resistance to piping.	Moderate permeability; well drained.	Moderate to rapid intake rate; low to moderate available water capacity; 2 to 70 percent slopes.	Not applicable.	Low to moderate available water capacity; vegetation difficult to establish.
Very low shear strength; high shrink-swell potential; seasonal high water table.	Moderate stability; semipervious to impervious where compacted; high shrink-swell potential; cracks when dry.	Slow permeability; seasonal high water table 16 inches or less below surface.	Very low shear strength; semipervious to impervious where compacted; very high compressibility; moderate stability; cracks when dry.	Slow permeability; seasonal high water table.	Slow intake rate; very high available water capacity.	Not applicable.	Very high available water capacity; vegetation easy to establish.
Very low shear strength; high shrink-swell potential; water table at depth of 16 to 30 inches; medium compressibility.	Low stability; semipervious to impervious where compacted; high shrink-swell potential; poor resistance to piping.	Moderately slow permeability; water table at depth of 16 to 30 inches.	Very low shear strength; semipervious to impervious where compacted; medium compressibility; low to moderate stability; poor resistance to piping.	Moderately slow permeability; seasonal high water table.	Moderate intake rate; seasonal water table at depth of 16 to 30 inches; high available water capacity.	Moderately slow permeability.	High available water capacity; vegetation easy to establish.
Very low shear strength; moderate shrink-swell potential; medium to high compressibility; water table at depth of 24 to 30 inches; flood hazard.	Low stability; semipervious to impervious where compacted; moderate shrink-swell potential; cracks when wet; poor resistance to piping.	Moderate permeability; seasonal water table at depth of 24 to 30 inches.	Very low shear strength; semipervious to impervious where compacted; medium to high compressibility; low stability; cracks when dry; poor resistance to piping.	Moderate permeability; seasonal high water table; flood hazard.	Moderate intake rate; very high available water capacity; water table at depth of 24 to 30 inches.	Not applicable.	Very high available water capacity; vegetation easy to establish.
Very low shear strength; moderate shrink-swell potential; medium to very high compressibility; 2 to 70 percent slopes.	Low stability; semipervious to impervious where compacted; moderate shrink-swell potential; poor resistance to piping.	Moderately slow permeability; 2 to 70 percent slopes.	Very low shear strength; semipervious to impervious where compacted; medium to very high compressibility; low stability; poor resistance to piping.	Moderately slow permeability.	Moderate intake rate; high available water capacity; 2 to 70 percent slopes.	High available water capacity; moderately slow permeability.	High available water capacity; vegetation fairly easy to establish.

TABLE 5.—*Engineering interpretations*

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Trafficability (off road for heavy equipment)	Winter grading
Minniece (MYB)	Fair: excessive fine material.	Not suitable: thick overburden.	Not suitable: thick overbudren.	Poor: very low shear strength; A–6 or A–7 material.	Very slow permeability; moderate susceptibility to frost heave; high shrink-swell potential; seasonal high water table; seepage; low to moderate stability.	Very low shear strength; low to high bearing capacity; very slow permeability; seasonal high water table; seepage.	Poor trafficability; plastic when wet and difficult to excavate; high water table.
Nekia (NeB, NeC, NeD, NeE, NeF, NkC, NsE, NsF).	Fair: excessive fine material.	Not suitable: excessive fine material over basalt bedrock.	Not suitable; possible source of basalt for crushing.	Fair to poor: very low shear strength; A–5 and A–6 matreial.	Moderately slow permeability; moderate shrink-swell potential; low to moderate stability.	Very low shear strength; low to moderate bearing capacity; moderately slow permeability.	Poor trafficability; plastic when wet and difficult to excavate.
Newberg (Nu, Nw)	Good	Fair to poor: thick overburden; excessive fine material.	Poor to not suitable: thick overburden.	Fair to good: low shear strength; A–2 and A–4 material.	Moderately rapid permeability; flood hazard; low stability; low shrink-swell potential.	Low shear strength; high bearing capacity; moderately rapid permeability; flood hazard.	Good trafficability; easy to excavate.
Salem (Sa)	Fair: excessive gravel.	Not suitable: excessive gravel and fine material.	Fair: overburden 30 inches thick.	Poor to depth of 30 inches; good below 30 inches; very low shear strength; A–7 and A–1 material.	Moderate permeability; low to moderate shrink-swell potential; low stability.	Very low shear strength; low bearing capacity; moderate permebility.	Poor trafficability; plastic when wet and difficult to excavate.

for specified uses—Continued

Soil features affecting—Continued							
Foundations for low buildings	Dikes	Farm ponds: Reservoir area	Farm ponds: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
Very low shear strength; high shrink-swell potential; water table 6 inches or less below surface.	Low to moderate stability; semipervious to impervious where compacted; high shrink-swell potential; poor to fair resistance to piping.	Very slow permeability; seasonal high water table; 0 to 8 percent slopes.	Very low shear strength; semipervious to impervious where compacted; very high compressibility; low to moderate stability; cracks when dry; poor to fair resistance to piping.	Very slow permeability; seasonal high water table; seepage.	Moderate to slow intake rate; moderate available water capacity.	Moderate available water capacity; very slow permeability.	Moderate available water capacity; vegetation fairly easy to establish.
Very low shear strength; moderate shrink-swell potential; medium to very high compressibility; 2 to 50 percent slopes.	Low to moderate stability; semipervious to impervious where compacted; moderate shrink-swell potential; poor to fair resistance to piping.	Moderately slow permeability; 2 to 50 percent slopes.	Very low shear strength; semipervious to impervious where compacted; medium to very high compressibility; low to moderate stability; poor to fair resistance to piping.	Moderately slow permeability; well drained.	Moderate intake rate; low to moderate available water capacity; 2 to 50 percent slopes.	Low to moderate available water capacity; moderately slow permeability.	Low to moderate available water capacity; vegetation fairly easy to establish.
Low shear strength; low shrink-swell potential; slight compressibility.	Low stability; semipervious to impervious where compacted; low shrink-swell potential; poor resistance to piping.	Moderately rapid permeability.	Low shear strength; semipervious to impervious where compacted; slight compressibility; low stability; poor resistance to piping.	Moderately rapid permeability.	Moderate to rapid intake rate; moderate available water capacity.	Not applicable.	Moderate available water capacity; vegetation fairly easy to establish.
Very low shear strength; low to moderate shrink-swell potential; slight to medium compressibility.	Low stability; semipervious to impervious where compacted; low to moderate shrink-swell potential; poor to fair resistance to piping.	Moderate permeability; permeable gravel can occur at depth of 20 to 40 inches.	Very low shear strength; semipervious to impervious where compacted; slight to medium compressiblity; low stability; poor to fair resistance to piping.	Moderate permeability; well drained.	Moderate intake rate; moderate available water capacity.	Not applicable.	Not applicable.

TABLE 5.—*Engineering interpretations*

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Trafficability (off road for heavy equipment)	Winter grading
Salkum: (SkB, SkD)	Fair: excessive fine material.	Not suitable: excessive fine material.	Not suitable: excessive fine material; gravel soft and weathered.	Poor: A–6 or A–7 material.	Slow permeability; moderate shrink-swell potential; low to moderate stability.	Very low shear strength; low to moderate bearing capacity; slow permeability.	Poor trafficability; plastic when wet and difficult to excavate.
(SlB)	Fair: excessive fine material.	Not suitable: excessive fine material.	Not suitable: excessive fine material; gravel is soft and weathered.	Poor: A–6 or A–7 material.	Slow permeability; moderate shrink-swell potential; seasonal high water table caused by seepage.	Very low shear strength; low to moderate bearing capacity; slow permeability; seasonal high water table caused by seepage.	Poor trafficability; plastic when wet and difficult to excavate.
Santiam (SnA, SnB, SnC).	Good	Not suitable: excessive fine material.	Poor to not suitable: excessive fine material; thick overburden.	Poor: low stability; A–6 and A–7 material.	Slow and moderately slow permeability; high shrink-swell potential; seasonal high water table.	Very low shear strength; low to moderate bearing capacity; seasonal high water table.	Poor trafficability; plastic when wet and difficult to excavate
Semiahmoo (So)	Good	Not suitable: organic soil.	Not suitable: organic soil.	Not suitable: organic soil.	Low volume weight; low strength; high water table; under water part of the time.	Very low shear strength and bearing capacity; moderate permeability; high water table; under water part of the time.	Very poor trafficability; high water table; very low bearing capacity.
Sifton (St)	Poor: excessive gravel.	Poor: excessive gravel.	Good	Good below depth of 24 inches; low to moderate stability; A–1 material.	Moderately rapid permeability; low shrink-swell potential; low to moderate stability.	Low to moderate shear strength; high bearing capacity; moderately rapid permeability.	Good trafficability.

for specified uses—Continued

Soil features affecting—Continued							
Foundations for low buildings	Dikes	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
		Reservoir area	Embankment				
Very low shear strength; moderate shrink-swell potential; medium compressibility; 2 to 20 percent slopes.	Low to moderate stability; semipervious to impervious where compacted; moderate shrink-swell potential; poor to fair resistance to piping.	Slow permeability.	Very low shear strength; semipervious to impervious where compacted; medium compressibility; low to moderate stability; poor to fair resistance to piping.	Slow permeability.	Moderate intake rate; high available water capacity; 2 to 20 percent slopes.	High available water capacity; slow permeability.	High available water capacity; vegetation fairly easy to establish.
Very low shear strength; moderate shrink-swell potential; medium compressibility; 0 to 6 percent slopes.	Low to moderate stability; semipervious to impervious where compacted; moderate shrink-swell potential.	Slow permeability.	Very low shear strength; semipervious to impervious where compacted; medium compressibility; low to moderate stability.	Slow permeability; seepage.	Moderate intake rate; high available water capacity.	Not applicable.	High available water capacity; vegetation easy to establish.
Very low shear strength; high shrink-swell potential; medium to high compressibility; water table 6 to 24 inches below surface; 0 to 15 percent slopes.	Low stability; semipervious to impervious where compacted; high shrink-swell potential; poor to fair resistance to piping.	Slow and moderately slow permeability; 0 to 15 percent slopes.	Very low shear strength; semipervious to impervious where compacted; medium to high compressibility; low stability; poor to fair resistance to piping.	Slow and moderately slow permeability; seasonal high water table.	Moderate intake rate; high available water capacity; 0 to 15 percent slopes.	Slow and moderately slow permeability.	High available water capacity; vegetation easy to establish.
Very low bearing capacity; high water table.	Low stability; highly organic.	Moderate permeability; low strength; low volume weight; high water table.	Low shear strength; low volume weight; high water table; highly organic.	Moderate permeability; high water table.	Moderate intake rate; very high available water capacity.	Not applicable.	Very high available water capacity; vegetation easy to establish.
Low to moderate shear strength; low shrink-swell potential; slight to very slight compressibility.	Low to moderate stability; pervious where compacted; low shrink-swell potential; poor to fair resistance to piping.	Moderately rapid permeability.	Moderate to low shear strength; pervious where compacted; slight to very slight compressibility; low to moderate stability; poor to fair resistance to piping.	Moderately rapid permeability.	Rapid intake rate; low available water capacity.	Not applicable.	Not applicable.

TABLE 5.—*Engineering interpretations*

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Trafficability (off road for heavy equipment)	Winter grading
Silverton (SuC, SuD).	Good	Not suitable: excessive fine material.	Not suitable: possible source of basalt for crushing.	Fair to poor: low stability; A–4 and A–7 material.	Moderately slow permeability; moderate to high shrink-swell potential; low stability.	Very low shear strength; low bearing capacity; moderately slow permeability.	Poor trafficability; plastic when wet and difficult to excavate.
Stayton (SvB)	Good	Not suitable: excessive fine material over basalt bedrock.	Not suitable: excessive fine material over basalt bedrock.	Fair: low stability; A–4 material.	Moderate permeability; low stability; low shrink-swell potential.	Very low shear strength; low bearing capacity; moderate permeability.	Very poor trafficability.
*Steiwer (SwB, SwD, SCE). (For Chehulpum part of SCE, see Chehulpum series.)	Good	Not suitable: excessive fine material over bedrock.	Not suitable: excessive fine material over bedrock.	Fair to poor: low stability; A–4 and A–7 material.	Moderately slow permeability; moderate shrink-swell potential; low stability.	Very low shear strength; low bearing capacity; moderately slow permeability.	Poor trafficability; 3 to 40 percent slopes.
Waldo (Wa)	Fair: excessive fine material.	Not suitable: excessive fine material; thick overburden.	Not suitable: thick overburden.	Poor: low stability; A–6 and A–7 material.	Slow permeability; high shrink-swell potential; seasonal high water table; low stability.	Very low shear strength; low to moderate bearing capacity; slow permeability; seasonal high water table.	Poor trafficability; plastic when wet and difficult to excavate; high water table.

for specified uses—Continued

Soil features affecting—Continued							
Foundations for low buildings	Dikes	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
		Reservoir area	Embankment				
Very low shear strength; moderate to high shrink-swell potential; medium compressibility; 0 to 20 percent slopes.	Low stability; semipervious to impervious where compacted; moderate to high shrink-swell potential; poor resistance to piping.	Moderately slow permeability; bedrock or gravelly substratum at depth of 20 to 40 inches.	Very low shear strength; semipervious to impervious where compacted; medium compressibility; low stability; poor resistance to piping.	Moderately slow permeability.	Moderate intake; rate; low to moderate available water capacity; 0 to 20 percent slopes.	Moderately slow permeability.	Low to moderate available water capacity; vegetation easy to establish.
Very low shear strength; low shrink-swell potential; medium compressibility; bedrock at depth of 15 to 20 inches.	Very low stability; semipervious to impervious where compacted; low shrink-swell potential; poor resistance to piping.	Moderate permeability; bedrock at depth of 15 to 20 inches.	Very low shear strength; semipervious to impervious where compacted; medium compressibility; very low stability; poor resistance to piping.	Moderate permeability.	Moderate intake rate; low available water capacity; shallow.	Moderate permeability.	Low available water capacity; vegetation fairly difficult to establish; bedrock at depth of 15 to 20 inches.
Very low shear strength; moderate shrink-swell potential; medium to high compressibility; bedrock at depth of 20 to 40 inches.	Low stability; semipervious to impervious where compacted; modderate shrink-swell potential; poor to fair resistance to piping.	Moderately slow permeaiblity; bedrock at depth of 20 to 40 inches.	Very low shear strength; semipervious to impervious where compacted; medium to high compressibility; low stability; poor to fair resistance to piping.	Moderately slow permeability.	Moderate intake rate; low to moderate available water capacity; moderately deep; 3 to 40 percent slopes.	Moderately slow permeability; bedrock at depth of 20 to 40 inches.	Moderate to low available water capacity; vegetation fairly difficult to establish; bedrock at depth of 20 to 40 inches.
Very low shear strength; high shrink-swell potential; medium to very high compressibility; water table 6 inches or less below surface.	Low stability; semipervious to impervious where compacted; high shrink-swell potential; cracks when dry; poor to fair resistance to piping.	Slow permeability.	Very low shear strength; semipervious to impervious where compacted; medium to very high compressibility; low stability; cracks when dry; poor to fair resistance to piping.	Slow permeability; seasonal high water table.	Moderate intake rate; high available water capacity.	Not applicable.	High available water capacity; vegetation fairly difficult to establish.

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TABLE 5.—*Engineering interpretations*]

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Trafficability (off road for heavy equipment)	Winter grading
Wapato (Wc)	Fair: excessive fine material.	Not suitable: excessive fine material; thick overburden.	Not suitable: excessive fine material; thick overburden.	Poor: low stability; A–6 material.	Moderately slow permeability; moderate shrink-swell potential; seasonal high water table; low stability; flood hazard.	Very low shear strength; low to moderate bearing capacity; moderately slow permeability; seasonal high water table.	Poor trafficability; high water table; plastic when wet and difficult to excavate.
Whetstone (WHE, WHF, WHG).	Poor to not suitable: stones, pebbles, and cobblestones throughout profile.	Poor: excessive fine material over bedrock.	Good to poor: excessive fine material; possible source of basalt for crushing.	Good to fair: medium to high stability; A–2 to A–4 material.	Moderate susceptibility to frost heave; moderate permeability; low shrink-swell potential; medium to high stability.	Moderate shear strength; high bearing capacity; moderate permeability.	Fair trafficability; stones on surface; 3 to 75 percent slopes.
Willamette (WIA, WIC).	Good	Not suitable: excessive fine material; thick overburden.	Not suitable: thick overburden.	Fair to poor: low stability; A–4 to A–7 material.	Moderate permeability; moderate shrink-swell potential; low stability.	Very low shear strength; low bearing capacity; moderate permeability.	Fair trafficability; difficult to excavate.
Witzel (WtE)	Poor: very stony.	Not suitable: excessive stones and fine material over bedrock.	Not suitable: possible source of basalt for crushing.	Poor: moderate stability; very stony and cobbly.	Moderately slow permeability; low shrink-swell potential; low stability.	Moderate to low shear strength; moderate bearing capacity; moderately slow permeability.	Poor trafficability; surface layer very stony; 3 to 40 percent slopes.

for specified uses—Continued

Soil features affecting—Continued							
Foundations for low buildings	Dikes	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
		Reservoir area	Embankment				
Very low shear strength; moderate shrink-swell potential; high water table; medium to very high compressibility; flood hazard.	Low stability; semipervious to impervious where compacted; moderate shrink-swell potential; cracks when dry; poor to fair resistance to piping.	Moderately slow permeability; flood hazard.	Very low shear strength; semipervious to impervious where compacted; medium to very high compressibility; low stability; cracks when dry; poor to fair resistance to piping.	Moderately slow permeability; seasonal high water table.	Moderate intake rate; high available water capacity.	Not applicable.	High available water capacity; vegetation fairly easy to establish.
Moderate shear strength; low shrink-swell potential; slight compressibility; 3 to 75 percent slopes.	Medium to high stability; semipervious to very pervious where compacted; low shrink-swell potential; poor resistance to piping.	Moderate permeability; 3 to 75 percent slopes.	Moderate shear strength; semipervious to very pervious where compacted; slight compressibility; high to medium stability; poor resistance to piping.	Moderate permeability.	Moderate intake rate; low available water capacity; 3 to 75 percent slopes.	Not applicable.	Low available water capacity; vegetation fairly difficult to establish.
Very low shear strength; moderate shrink-swell potential.	Low stability; semipervious to impervious where compacted; moderate shrink-swell potential; poor to fair resistance to piping.	Moderate permeability.	Very low shear strength; semipervious to impervious where compacted; medium compressibility; low stability; poor to fair resistance to piping.	Moderate permeability.	Moderate intake rate; high available water capacity; 0 to 12 percent slopes.	Moderate permeability.	High available water capacity; vegetation easy to establish.
Moderate to low shear strength; low shrink-swell potential; slight compressibility; 3 to 40 percent slopes.	Moderate stability; semipervious to impervious where compacted; low shrink-swell potential; poor resistance to piping.	Moderately slow permeability; bedrock at depth of 12 to 20 inches; 3 to 40 percent slopes.	Low to moderate shear strength; semipervious to impervious where compacted; slight compressibility; moderate stability; poor resistance to piping; many stones.	Moderately slow permeability.	Moderate intake rate; very low available water capacity; 3 to 40 percent slopes.	Not applicable.	Very low available water capacity; vegetation very difficult to establish; stony; bedrock at depth of 12 to 20 inches.

TABLE 5.—*Engineering interpretations*

Soil series and map symbol	Suitability as source of—				Soil features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Trafficability (off road for heavy equipment)	Winter grading
Woodburn (WuA, WuC, WuD).	Good	Not suitable: excessive fine material.	Not suitable: thick overburden.	Fair to poor: low stability; A-4 to A-6 material.	Slow permeability; moderate shrink-swell potential; low stability.	Very low shear strength; low bearing capacity; slow permeability.	Poor trafficability; plastic when wet and difficult to excavate.

Engineering classification systems

Agricultural scientists of the United States Department of Agriculture classify soils according to texture (*13*). In some ways this system of naming textural classes is comparable to the systems most commonly used by engineers for classifying soils; that is, the system of the American Association of State Highway Officials (AASHO) and the Unified system.

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (*1*). In this system soil materials are classified in seven principal groups. The groups range from A-1 (gravelly soils having high bearing capacity, the best soils for subgrade), to A-7 (clayey soils having low strength when wet, the poorest soils for subgrade). Within each group the relative engineering value of the soil material is indicated by a group index number. Group index numbers range from 0 for the best material to 20 for the poorest. The group index number is shown in parentheses following the soil group symbol in table 3.

Some engineers prefer to use the Unified Soil Classification System (*16*). In this system soil materials are identified as coarse grained, eight classes; fine grained, six classes; and highly organic. The last column in table 3 gives the classification of the tested soils according to the Unified system.

Engineering test data

Soil samples for soil profiles representing several extensive soil series in the Marion County Area were obtained at representative locations by the Soil Conservation Service. These samples were tested by the Engineering Experiment Station of Oregon State University in cooperation with the Oregon State Highway Department, the Bureau of Public Roads, and the Soil Conservation Service, in accordance with standard procedures of AASHO to help evaluate the soils for engineering purposes. The results of these tests and the classification of each soil sample according to both the AASHO and the Unified systems are shown in table 3.

The samples tested do not represent the entire range of soil characteristics in the survey area, or even within the soil series sampled. The results of the tests, however, can be used as a general guide in estimating the physical properties of the soils in the survey area. Data in the table are based on tests made for moisture-density relationships, mechanical analysis, and tests for liquid limit and plasticity index.

In the moisture-density, or compaction test, a sample of the soil material is compacted several times, using a constant compactive effort, each time at a successively higher moisture content. The moisture content increases until the optimum moisture content is reached. After that, the density decreases with increase in moisture content. The highest density obtained in the compaction test is termed "maximum density." Moisture-density data are important in construction, for as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

The results of the mechanical analysis, obtained by combined sieve and hydrometer methods, may be used to determine the relative proportions of the different size particles that make up the soil sample. The percentage of fine-grained material, obtained by the hydrometer method, which generally is used by engineers, should not be used in determining textural classes of soils.

The tests to determine liquid limit and plastic limit measure the effect of water on consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the soil material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range in moisture content within which a soil material is in a plastic condition.

for specified uses—Continued

Soil features affecting—Continued							
Foundations for low buildings	Dikes	Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways
		Reservoir area	Embankment				
Very low shear strength; moderate shrink-swell potential; medium compressibility; perched water table; 0 to 20 percent slopes.	Low stability; semipervious to impervious where compacted; moderate shrink-swell potential; poor to fair resistance to piping.	Slow permeability.	Very low shear strength; semipervious to impervious where compacted; medium compressibility; low stability; poor to fair resistance to piping.	Slow permeability; seasonal perched water table.	Moderate intake rate; high to very high available water capacity; 0 to 20 percent slopes.	Slow permeabillity.	High to very high available water capacity; vegetation easy to establish.

Engineering properties of soils

The estimated engineering properties significant to engineering for soils mapped in the survey area are given in table 4. These estimated properties are those of typical soils. A single numerical entry in the table indicates an estimated average value for the particular characteristic. A range in values is shown where the expected variation is reasonably certain. Where test data were available, that information was used. Where no test data were available, estimates in table 4 are based on comparisons with soils that were tested in the survey area, and with similar soils in other counties.

The meaning of hydrologic groups shown in table 4 may not be familiar to some persons who use this soil survey. These data are used in estimating the total volume and peak runoff that can be expected from storms of a given amount and intensity, and they are useful in planning measures to control water. In group A are coarse textured and moderately coarse textured soils that can transmit water through their profile and substratum at a rapid rate. These soils can absorb the precipitation that results from most storms, and they have the highest rate of infiltration, even when they are throughly wet, and the lowest runoff potential of any of the soils in the survey area. In group B are the moderately coarse textured to moderately fine textured, deep or very deep soils that transmit water through their profile at a moderate rate. These soils have a moderate runoff potential. In group C are the moderately coarse textured to fine-textured, deep to shallow soils that transmit water through their profile at a slow rate. These soils have a high runoff potential. In group D are the medium-textured, moderately fine textured, and fine textured soils. Some soils in this group have a high water table, some have a thin mantle of soil over impervious material, some have a surface layer consisting of impervious material, and some are very deep. Soils in group D have the highest runoff potential of any soils in the survey area.

Estimates of permeability are for the soil in place. They are based on the structure, texture, and porosity of the soil material and on field observations.

The available water capacity, given in inches per inch of soil, refers to the approximate amount of capillary water in a soil that is wet to field capacity. When the soil is air dry, this amount of water will wet the soil material to a depth of 1 inch without deeper percolation.

Reaction gives the intensity of acidity or alkalinity of the soil, expressed in pH values. A pH notation of 7.0 is neutral. A lower value indicates acidity, and a higher value indicates alkalinity.

Corrosivity indicates the potential danger to uncoated metal or concrete structures through chemical action that dissolves or weakens the structural material. Structural material may corrode if it is buried in soil, and a given material corrodes in some kinds of soil more rapidly than in others. Extensive installations that intersect soil boundaries or soil horizons are more likely to be damaged by corrosion than are installations entirely within one kind of soil or soil horizon.

Shrink-swell potential is an indication of the volume change to be expected in the soil material with changes in content of moisture. Shrinking and swelling of soils cause much damage to the foundations of buildings and to roads and other structures. A high shrink-swell potential indicates hazards to the maintenance of structures constructed in, on, or with such materials.

Engineering interpretations

Table 5 provides suitability ratings of soils as a source of topsoil, sand, gravel, and road fill. It also gives soil features that affect location and work on highways, off-road trafficability for heavy equipment, winter grading, foundations for low buildings, and structures that conserve soil and water. Interpretations are based on test data and on field experience with soils in the survey area and with similar soils.

Climate, physiography, and geology greatly affect the engineering uses of soils. In the survey area, the temperature is mild throughout the year. Average annual precipitation ranges from 40 to 90 inches. At elevations of less than 2,000 feet, precipitation occurs as intermittent rains of low intensity; at elevations higher than 2,000 feet, some precipitation occurs as snow; and at elevations higher than 3,000 feet, snow covers the ground during winter and spring.

The porous, stable aggregates in most soils of the survey area allow the absorption of most of the precipitation. Permeability and intake rates are moderate to moderately slow for most of the soils. The climate favors the accumulation of large amounts of organic material in the surface layer. Consequently, most of the soils are a good source of topsoil, though such highly organic material must be removed if the soils are to be used for many engineering purposes. In table 5 the suitability of the soils as a source of topsoil refers to soil material, preferably rich in organic matter, that is used as a topdressing for roadbanks, lawns, gardens, and other areas where a good seedbed is needed so that plants can be established.

Ratings of the suitability of the soils as a source of sand and gravel are based on the expected stratification and gradation of the material, on the amount of fines in the material, and on other features that affect the source. A detailed investigation at the site of a probable source is needed to determine the suitability of sandy or gravelly material for a specific use.

Features considered in rating soils for use as road fill are plasticity, wetness, compaction characteristics, hazard of erosion, stones in and on the soil, and depth to bedrock. Highly organic soils and some highly plastic clays are not suitable for road fill.

The entire profile was considered in determining the suitability of the soils as a location for highways. Features considered were those of an undisturbed soil without artificial drainage. Most of the larger towns and intensively used areas are on alluvial terraces adjacent to streams and low foothills. On these terraces the water table is generally high during winter and spring, and this affects suitability of the soils as a location for highways. In the eastern part of the survey area, movement of unstable masses of rock seriously affects use of some soils for roads, especially after prolonged rains.

Features that affect trafficability are those that affect use of the soils for off-road operation of vehicles and heavy equipment that may be used in logging. Some soils can be used in all seasons for moving heavy equipment, but others can bear only a light load at certain times of the year.

Features that affect winter grading are those that affect movement of earth in construction.

Characteristics of the substratum are important in selecting the proper location for a building no higher than three stories, for the foundation generally rests on this part of the soil. Among the critical features are bearing capacity, shear strength, shrink-swell potential, compressibility, depth to bedrock, and depth to the water table.

Information relating to use of the soils for dikes refers to structures used to protect areas along streams from frequent overflow. Many soils of the survey area are suitable for use in constructing dikes, but they are far removed from areas where dikes are likely to be needed.

Features that influence use of a soil for the reservoir area of a farm pond are permeability, depth to bedrock, depth

TABLE 6.—*Degree and kind of limitations for*

Soil mapping units	Farming	Residential development with sewage disposal by—	
		Septic tank	Public sewer
Abiqua silty clay loam, 0 to 3 percent slopes	Slight	Severe: moderately slow permeability.	Slight
Abiqua silty clay loam, 3 to 5 percent slopes	Slight	Severe: moderately slow permeability.	Slight
Alluvial land	Severe: flood hazard	Severe: flood hazard	Severe: flood hazard
Amity silt loam	Slight	Severe. moderately slow permeability; high water table.	Moderate: seasonal high water table.
Bashaw clay	Severe: poorly drained	Severe: very slow permeability.	Severe: poorly drained
Camas gravelly sandy loam	Severe: flood hazard; droughty.	Severe: flood hazard	Severe: flood hazard
Chehalem silt loam, 2 to 12 percent slopes	Moderate: somewhat poorly drained.	Severe: slow permeability.	Moderate: seasonal high water table.
Chehalis silty clay loam	Slight	Moderate: moderate permeability.	Slight
Chehulpum silt loam (Mapped only in an undifferentiated unit with Steiwer soils.)	Severe: bedrock at depth of 10 to 20 inches.	Severe: bedrock at depth of 10 to 20 inches.	Severe: bedrock at depth of 10 to 20 inches.

to the water table, and depth and permeability of the substratum. Features affecting use of a soil for embankments are soil stability, compaction characteristics, and perviousness of the compacted soil material. In table 5 the features shown for reservoir areas are those of an undisturbed soil. Features shown for embankments are those of soil material that has been disturbed. Some soils are too steep to be suitable as a site for a reservoir, but they are suitable for use in the embankment of a reservoir at a more favorable site.

Factors that affect the suitability of a soil for agricultural drainage are texture, rate of water movement into and through the soil, depth to the water table, and position of the soil on the landscape.

The main features considered in determining suitability of a soil for irrigation are the available water capacity and the rate at which water is taken into the soil. Also important are depth to the water table, depth to soil material that restricts the root zone, and topography.

Features that determine suitability of a soil for terraces and diversions are slope, depth of the soil, and soil stability. Depth of the soil must be adequate for the excavation of a shallow channel that will carry flowing water. Stability affects the ease or difficulty of maintaining the terrace or diversion. For soils that are level or nearly level, and for soils not suited to cultivation, "not applicable" is shown in the column giving features that affect suitability for terraces and diversions.

Features that affect suitability of a soil for establishing and maintaining vegetation in a waterway are hazard of erosion, reaction, and natural fertility. For soils that are level or nearly level, and for soils that do not require waterways, "not applicable" is shown in the column giving features that affect suitability for grassed waterways.

Town and Country Planning

Uses of the soils in the survey area are intermixed, and they tend to compete with one another. Farmland and woodland are being taken for the development of facilities for transportation, industries, recreation, and residences. When use of the land changes, new problems involving soil and water conservation arise. This section evaluates the soil properties that can influence the suitability of soils for various town and country uses. The information is intended to serve as a guide for land use planners and others who are concerned about possible limitations of soils for various intended uses.

Table 6 provides information on the degree and kind of soil limitations for stated uses in town and country planning. This information is not intended to eliminate the need for onsite study and testing of the soils. Soil manipulation that accompanies the making of extensive cuts and fills generally alters a soil to the extent that this information is no longer applicable.

In making the ratings shown in table 6, all soil features that affect the application of a stated land use were evaluated. A soil that has no limiting features or only minor ones was given a rating of *slight.* A rating of *moderate* means that the soil has limitations that can be overcome.

stated uses in town and country planning

Residential developments with sewage disposal by—Continued	Industrial development	Transportation	Recreational areas	
Sewage lagoons			Camping and picnicking	Paths and trails
Slight	Slight	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam.	Moderate: silty clay loam.
Moderate: slopes	Slight	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam.	Moderate: silty clay loam.
Severe: flood hazard	Severe: flood hazard	Severe: flood hazard	Severe: flood hazard	Severe: flood hazard.
Slight	Moderate: seasonal high water table.	Severe: seasonal high water table.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.
Slight	Severe: poorly drained	Severe: high shrink-swell potential.	Severe: poorly drained	Severe: poorly drained.
Severe: flood hazard; very rapid permeability.	Severe: flood hazard	Severe: flood hazard	Severe: flood hazard	Moderate: flood hazard.
Moderate to severe: slopes.	Severe: seasonal high water table.	Severe: seasonal high water table.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.
Moderate: moderate permeability.	Slight	Slight	Moderate: silty clay loam.	Moderate: silty clay loam.
Severe: bedrock at depth of 10 to 20 inches; slopes.	Severe: bedrock at depth of 10 to 20 inches.	Severe: slopes	Severe: slopes	Slight to severe: slopes.

TABLE 6.—*Degree and kind of limitations for*

Soil mapping units	Farming	Residential development with sewage disposal by—	
		Septic tank	Public sewer
Clackamas gravelly loam	Moderate: somewhat poorly drained.	Severe: moderately slow permeability.	Moderate: seasonal high water table.
Cloquato silt loam	Slight	Severe: flood hazard	Severe: flood hazard
Concord silt loam	Moderate: poorly drained.	Severe: slow permeability.	Severe: high water table.
Courtney gravelly silty clay loam	Severe: poorly drained	Severe: very slow permeability.	Severe: seasonal high water table.
Cumley silty clay loam, 2 to 20 percent slopes	Moderate: slopes	Severe: moderately slow permeability.	Slight to moderate: slopes.
Dayton silt loam	Severe: poorly drained	Severe: very slow permeability.	Severe: seasonal high water table.
Hazelair silt loam, 2 to 6 percent slopes	Moderate: slopes; slow permeability.	Severe: slow permeability.	Severe: seasonal high water table.
Hazelair silt loam, 6 to 20 percent slopes	Severe: slopes	Severe: slow permeability.	Severe: high shrink-swell potential.
Hazelair silty clay loam, 2 to 15 percent slopes, eroded	Severe: slopes; surface layer thin.	Severe: slow permeability.	Severe: high shrink-swell potential.
Henline very stony sandy loam, 6 to 30 percent slopes	Severe: slopes; elevation.	Severe: bedrock at depth of 20 to 40 inches; slopes.	Severe: bedrock at depth of 20 to 40 inches; slopes.
Henline very stony sandy loam, 30 to 55 percent slopes.	Severe: slopes	Severe: slopes	Severe: slopes
Henline very stony sandy loam, 55 to 80 percent slopes.	Severe: slopes	Severe: slopes	Severe: slopes
Holcomb silt loam	Moderate: somewhat poorly drained.	Severe: very slow permeability.	Severe: seasonal high water table.
Horeb loam, 2 to 20 percent slopes	Moderate: slopes	Moderate to severe: slopes.	Slight to moderate: slopes.
Horeb gravelly silt loam, gravelly substratum, 0 to 15 percent slopes.	Moderate: slopes	Slight to severe: slopes	Slight
Horeb gravelly silt loam, gravelly substratum, 15 to 35 percent slopes.	Severe: slopes	Severe: slopes	Severe: slopes
Hullt clay loam, 2 to 7 percent slopes	Slight	Severe: moderately slow permeability.	Slight
Hullt clay loam, 7 to 20 percent slopes	Moderate: slopes	Severe: moderately slow permeability.	Moderate: slopes

stated uses in town and country planning—Continued

Residential developments with sewage disposal by—Continued: Sewage lagoons	Industrial development	Transportation	Recreational areas: Camping and picnicking	Recreational areas: Paths and trails
Moderate: substratum contains much gravel.	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.
Severe: flood hazard	Severe: flood hazard	Severe: flood hazard	Slight	Slight.
Slight to moderate	Severe: high water table.	Severe: high water table.	Severe: poorly drained	Severe: poorly drained.
Slight	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: poorly drained	Severe: poorly drained.
Moderate on slopes of 2 to 7 percent; severe on slopes stronger than 7 percent.	Moderate: slopes	Moderate: slopes	Slight to severe: slopes	Slight to moderate: slopes.
Slight to moderate	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: poorly drained	Severe: poorly drained.
Severe: bedrock at depth of 40 inches or less.	Severe: seasonal high water table.	Severe: high shrink-swell-potential.	Moderate: slow permeability.	Moderate: seasonal high water table.
Severe: bedrock at depth of 40 inches or less; slopes.	Severe: high shrink-swell potential.	Severe: high shrink-swell-potential.	Moderate to severe: slopes.	Moderate: slopes.
Severe: bedrock at depth of 40 inches or less; slopes.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Moderate: slopes	Moderate: slopes.
Severe: bedrock at depth of 20 to 40 inches; slopes; moderately rapid permeability.	Severe: slopes; elevation.	Severe: bedrock at depth of 20 to 40 inches; slopes.	Severe: slopes; stones	Moderate: slopes; stones.
Severe: slopes	Severe: slopes; elevation.	Severe: slopes	Severe: slopes; stones	Severe: slopes.
Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes.
Slight	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: very slow permeability; somewhat poorly drained.	Moderate: somewhat poorly drained.
Moderate on slopes of 2 to 7 percent; severe on slopes stronger than 7 percent.	Slight to moderate: slopes.	Slight to moderate: slopes.	Slight to severe: slopes	Slight to moderate: slopes.
Severe: porous gravel at depth of 40 inches; slopes.	Slight	Moderate: slopes	Slight to moderate: slopes.	Slight.
Severe: porous gravel at depth of 40 inches; slopes.	Severe: slopes	Severe: slopes	Severe: slopes	Moderate: slopes.
Moderate: slopes	Slight	Slight	Moderate: clay loam and silty clay loam.	Moderate: clay loam and silty clay loam.
Severe: slopes	Moderate: slopes	Moderate: slopes	Moderate to severe: clay loam and silty clay loam; slopes.	Moderate: clay loam and silty clay loam; slopes.

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TABLE 6.—*Degree and kind of limitations for*

Soil mapping units	Farming	Residential development with sewage disposal by—	
		Septic tank	Public sewer
Hullt clay loam, 20 to 30 percent slopes	Severe: slopes	Severe: moderately slow permeability; slopes.	Severe: slopes
Hullt clay loam, 30 to 60 percent slopes	Severe: slopes	Severe: slopes; moderately slow permeability.	Severe: slopes
Hullt clay loam, 2 to 20 percent slopes	Slight to moderate: slopes.	Severe: moderately slow permeability; slopes.	Slight to moderate: slopes.
Jory silty clay loam, 2 to 7 percent slopes	Slight	Severe: moderately slow permeability.	Slight
Jory silty clay loam, 7 to 12 percent slopes	Moderate: slopes	Severe: moderately slow permeability.	Moderate: slopes
Jory silty clay loam, 12 to 20 percent slopes	Moderate: slopes	Severe: moderately slow permeability; slopes.	Moderate: slopes
Jory silty clay loam, 20 to 30 percent slopes	Severe: slopes	Severe: slopes; moderately slow permeability.	Severe: slopes
Kinney cobbly loam, 2 to 20 percent slopes	Severe: cobblestones; elevation.	Moderate to severe: bedrock at depth of 40 to 60 inches; slopes.	Moderate: slopes
Kinney cobbly loam, 20 to 50 percent slopes	Severe: slopes; cobblestones.	Severe: slopes	Severe: slopes
Kinney cobbly loam, 50 to 70 percent slopes	Severe: slopes	Severe: slopes	Severe: slopes
Labish silty clay loam	Moderate: poorly drained.	Severe: slow permeability; flood hazard.	Severe: flood hazard
McAlpin silty clay loam, 0 to 3 percent slopes	Slight	Severe: moderately slow permeability.	Moderate: seasonal high water table.
McAlpin silty clay loam, 3 to 6 percent slopes	Slight	Severe: moderately slow permeability.	Moderate: seasonal high water table.
McBee silty clay loam	Slight	Moderate: seasonal high water table at depth of 24 to 30 inches.	Moderate: seasonal high water table at depth of 24 to 30 inches.
McCully clay loam, 2 to 7 percent slopes	Slight	Severe: moderately slow permeability.	Slight
McCully clay loam, 7 to 12 percent slopes	Moderate: slopes	Severe: moderately slow permeability.	Moderate: slopes
McCully clay loam, 12 to 20 percent slopes	Moderate: slopes	Severe: moderately slow permeability; slopes.	Moderate: slopes

stated uses in town and country planning—Continued

Residential developments with sewage disposal by—Continued	Industrial development	Transportation	Recreational areas	
Sewage lagoons			Camping and picnicking	Paths and trails
Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes	Moderate: slopes.
Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes.
Severe: slopes	Slight to moderate: slopes.	Slight to moderate: slopes.	Slight to severe: slopes.	Moderate: slopes; clay loam and silty clay loam.
Moderate: slopes	Slight	Slight	Moderate: silty clay loam.	Moderate.
Severe: slopes	Moderate: slopes	Moderate: slopes	Moderate: slopes; silty clay loam.	Moderate: silty clay loam.
Severe: slopes	Moderate: slopes	Moderate: slopes	Severe: slopes	Moderate: slopes; silty clay loam.
Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes	Moderate: slopes; silty clay loam.
Moderate on slopes of 2 to 7 percent; severe on slopes stronger than 7 percent; moderate permeability.	Moderate: slopes	Moderate: cobblestones; slopes.	Moderate to severe: cobblestones; slopes.	Moderate: slopes; cobblestones.
Severe: moderate permeability; slopes.	Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes.
Severe: moderate permeability; slopes.	Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes.
Severe: flood hazard	Severe: flood hazard	Severe: flood hazard	Severe: flood hazard; poorly drained.	Severe: flood hazard; poorly drained.
Moderate: moderately slow permeability; water table at depth of 16 to 30 inches.	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Moderate: silty clay loam.	Moderate: silty clay loam.
Moderate: moderately slow permeability; water table at depth of 16 to 30 inches.	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Moderate: silty clay loam.	Moderate: silty clay loam.
Severe: flood hazard	Moderate: seasonal high water table at depth of 24 to 30 inches.	Moderate: seasonal high water table at depth of 24 to 30 inches.	Moderate: silty clay loam and clay loam.	Moderate: clay loam and silty clay loam.
Moderate: slopes	Slight	Slight	Moderate: moderately slow permeability; clay loam.	Moderate: clay loam.
Severe: slopes	Moderate: slopes	Moderate: slopes	Moderate: clay loam; slopes.	Moderate: clay loam.
Severe: slopes	Moderate: slopes	Moderate: slopes	Severe: slopes	Moderate: clay loam; slopes.

TABLE 6.—*Degree and kind of limitations for*

Soil mapping units	Farming	Residential development with sewage disposal by—	
		Septic tank	Public sewer
McCully clay loam, 20 to 30 percent slopes	Severe: slopes	Severe: slopes	Severe: slopes
McCully clay loam, 30 to 50 percent slopes	Severe: slopes	Severe: slopes	Severe: slopes
McCully clay loam, 50 to 70 percent slopes	Severe: slopes	Severe: slopes	Severe: slopes
McCully clay loam, 2 to 30 percent slopes	Severe: slopes	Severe: moderately slow permeability; slopes.	Moderate to severe: slopes.
McCully stony clay loam, 2 to 20 percent slopes	Moderate: slopes; stones.	Severe: moderately slow permeability; slopes.	Moderate: slopes
McCully very stony clay loam, 2 to 30 percent slopes	Severe: slopes; stones	Severe: moderately slow permeability; slopes.	Moderate to severe: slopes.
Minniece silty clay loam, 0 to 8 percent slopes	Severe: poorly to somewhat poorly drained.	Severe: very slow permeability.	Severe: seasonal high water table.
Nekia silty clay loam, 2 to 7 percent slopes	Slight	Severe: moderately slow permeability; bedrock at depth of 20 to 40 inches.	Slight
Nekia silty clay loam, 7 to 12 percent slopes	Moderate: slopes	Severe: moderately slow permeability; bedrock at depth of 20 to 40 inches.	Moderate: slopes
Nekia silty clay loam, 12 to 20 percent slopes	Moderate: slopes	Severe: moderately slow permeability; bedrock at depth of 20 to 40 inches.	Moderate: slopes
Nekia silty clay loam, 20 to 30 percent slopes	Severe: slopes	Severe: moderately slow permeability; bedrock at depth of 20 to 40 inches.	Severe: slopes
Nekia silty clay loam, 30 to 50 percent slopes	Severe: slopes	Severe: slopes	Severe: slopes
Nekia stony silty clay loam, 2 to 12 percent slopes	Moderate: slopes; stones.	Severe: moderately slow permeability; bedrock at depth of 20 to 40 inches.	Moderate: slopes; stones.
Nekia very stony silty clay loam, 2 to 30 percent slopes.	Severe: slopes; stones	Severe: moderately slow permeability; bedrock at depth of 20 to 40 inches.	Severe: slopes; stones
Nekia very stony silty loam, 30 to 50 percent slopes	Severe: stones; slopes	Severe: slopes	Severe: slopes
Newberg fine sandy loam	Slight	Severe: flood hazard	Severe: flood hazard
Newberg silt loam	Slight	Severe: flood hazard	Severe: flood hazard

stated uses in town and country planning—Continued

Residential developments with sewage disposal by—Continued	Industrial development	Transportation	Recreational areas	
Sewage lagoons			Camping and picnicking	Paths and trails
Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes	Moderate: clay loam; slopes.
Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes.
Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes.
Moderate on slopes of 2 to 7 percent; severe on slopes stronger than 7 percent.	Moderate to severe: slopes.	Moderate to severe: slopes.	Moderate to severe: clay loam; slopes.	Moderate: clay loam; slopes.
Moderate on slopes of 2 to 7 percent; severe on slopes stronger than 7 percent.	Moderate to severe: slopes.	Moderate to severe: slopes.	Moderate to severe: clay loam; slopes; stones.	Moderate: slopes; stones; clay loam.
Moderate on slopes of 2 to 7 percent; severe on slopes stronger than 7 percent.	Moderate to severe: slopes.	Moderate to severe: slopes.	Moderate to severe: clay loam; slopes; stones.	Moderate: clay loam; stones.
Moderate: slopes	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: poorly to somewhat poorly drained.	Severe: poorly to somewhat poorly drained.
Severe: bedrock at depth of 20 to 40 inches; slopes.	Slight	Slight	Moderate: silty clay loam.	Moderate: silty clay loam.
Severe: bedrock at depth of 20 to 40 inches; slopes.	Moderate: slopes	Moderate: slopes	Moderate: slopes; texture.	Moderate: silty clay loam.
Severe: bedrock at depth of 20 to 40 inches; slopes.	Moderate: slopes	Moderate: slopes	Severe: slopes	Moderate: silty clay loam; slopes.
Severe: bedrock at depth of 20 to 40 inches; slopes.	Severe: slopes	Severe: slopes	Severe: slopes	Moderate: silty clay loam; slopes.
Severe: bedrock at depth of 20 to 40 inches; slopes.	Severe: slopes	Severe: slopes	Severe: slopes	Severe: slopes.
Severe: bedrock at depth of 20 to 40 inches; slopes.	Moderate: slopes	Moderate: slopes	Moderate: slopes; stones.	Moderate: silty clay loam.
Severe: bedrock at depth of 20 to 40 inches; slopes.	Severe: slopes; stones	Severe: slopes; stones	Severe: slopes; stones	Severe: slopes; stones.
Severe: bedrock at depth of 20 to 40 inches; slopes.	Severe: slopes	Severe: slopes	Severe: slopes; stones	Severe: slopes; stones.
Severe: flood hazard	Severe: flood hazard	Severe: flood hazard	Slight	Slight.
Severe: flood hazard	Severe: flood hazard	Severe: flood hazard	Slight	Slight.

TABLE 6.—*Degree and kind of limitations for*

Soil mapping units	Farming	Residential development with sewage disposal by—	
		Septic tank	Public sewer
Salem gravelly silt loam	Slight	Slight	Slight
Salkum silty clay loam, 2 to 6 percent slopes	Slight	Severe: slow permeability.	Slight
Salkum silty clay loam, 6 to 20 percent slopes	Moderate: slopes	Severe: slow permeability; slopes.	Moderate: slopes
Salkum silty clay loam, basin, 0 to 6 percent slopes	Slight	Severe: slow permeability.	Slight
Santiam silt loam, 0 to 3 percent slopes	Slight	Severe: moderately slow permeability.	Moderate: seasonal high water table.
Santiam silt loam, 3 to 6 percent slopes	Slight	Severe: moderately slow permeability.	Moderate: seasonal high water table.
Santiam silt loam, 6 to 15 percent slopes	Moderate: slopes	Severe: moderately slow permeability; slopes.	Moderate: seasonal high water table.
Semiahmoo muck	Moderate: poorly drained.	Severe: flood hazard	Severe: flood hazard
Sifton gravelly loam	Moderate: low available water capacity.	Slight	Slight
Silverton silt loam, 2 to 12 percent slopes	Slight	Severe: moderately slow permeability.	Slight
Silverton silt loam, 12 to 20 percent slopes	Moderate: slopes	Severe: moderately slow permeability.	Moderate: slopes
Stayton silt loam, 0 to 7 percent slopes	Severe: low available water capacity.	Severe: bedrock at depth of 15 to 20 inches.	Severe: bedrock at depth of 15 to 20 inches.
Steiwer silt loam, 3 to 6 percent slopes	Moderate: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches; moderately slow permeability.	Moderate: bedrock at depth of 20 to 40 inches.
Steiwer silt loam, 6 to 20 percent slopes	Severe: bedrock at depth of 20 to 40 inches; slopes.	Severe: moderately slow permeability; slopes.	Moderate: slopes
Steiwer and Chehulpum silt loams, 3 to 40 percent slopes. (Limitations are for Steiwer soil only. See Chehulpum silt loam for Chehulpum part.)	Severe: slopes; bedrock at depth of 20 to 40 inches.	Severe: slopes; bedrock at depth of 20 to 40 inches.	Severe: slopes

stated uses in town and country planning—Continued

Residential developments with sewage disposal by—Continued: Sewage lagoons	Industrial development	Transportation	Recreational areas: Camping and picnicking	Recreational areas: Paths and trails
Severe: very permeable gravel at depth of 20 to 40 inches.	Slight	Slight	Slight	Slight.
Moderate: slopes	Slight	Slight	Moderate: silty clay loam texture.	Moderate: silty clay loam.
Severe: slopes	Moderate: slopes	Moderate: slopes	Moderate to severe: silty clay loam texture; slopes.	Moderate: silty clay loam; slopes.
Moderate: slopes	Moderate: seepage	Moderate: seepage	Moderate: seasonal high water table; silty clay loam.	Moderate: silty clay loam; seasonal high water table.
Slight	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Slight	Slight.
Moderate: slopes	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Slight	Slight.
Severe: slopes	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Moderate: slopes	Slight.
Severe: moderate permeability.	Severe: flood hazard	Severe: flood hazard	Severe: flood hazard.	Severe: flood hazard.
Severe: moderately rapid permeability.	Slight	Slight	Slight	Slight.
Severe: rock at depth of 20 to 40 inches; slopes.	Slight	Slight	Moderate: moderately slow permeability; slopes.	Slight.
Severe: rock at depth of 20 to 40 inches; slopes.	Moderate: slopes	Moderate: slopes	Severe: slopes	Moderate to slight: slopes.
Severe: bedrock at depth of 15 to 20 inches.	Severe: bedrock at depth of 15 to 20 inches.	Severe: bedrock at depth of 15 to 20 inches.	Slight	Slight.
Severe: bedrock at depth of 20 to 40 inches.	Moderate: bedrock at depth of 20 to 40 inches.	Moderate: bedrock at depth of 20 to 40 inches.	Slight	Slight.
Severe: bedrock at depth of 20 to 40 inches; slopes.	Moderate: slopes	Moderate: slopes	Moderate to severe: slopes.	Moderate: slopes.
Severe: slopes; bedrock at depth of 20 to 40 inches.	Severe: slopes	Severe: slopes	Severe: slopes	Moderate to severe: slopes.

TABLE 6.—*Degree and kind of limitations for*

Soil mapping units	Farming	Residential development with sewage disposal by—	
		Septic tank	Public sewer
Stony rock land	Severe: not enough soil.	Severe: not enough soil.	Severe: not enough soil.
Terrace escarpments	Severe: steep slopes	Severe: steep slopes	Severe: steep slopes
Waldo silty clay loam	Moderate: poorly drained.	Severe: slow permeability.	Severe: seasonal high water table.
Wapato silty clay loam	Moderate: poorly drained.	Severe: moderately slow permeability.	Severe: seasonal high water table.
Whetstone stony loam, 3 to 25 percent slopes	Severe: slopes; climate	Severe: slopes; bedrock at depth of 20 to 40 inches.	Severe: slopes; bedrock at depth of 20 to 40 inches.
Whetstone stony loam, 25 to 55 percent slopes	Severe: slopes; climate	Severe: slopes	Severe: slopes
Whetstone stony loam, 55 to 75 percent slopes	Severe: slopes; climate	Severe: slopes	Severe: slopes
Willamette silt loam, 0 to 3 percent slopes	Slight	Slight	Slight
Willamette silt loam, 3 to 12 percent slopes	Slight	Moderate: slopes	Slight
Witzel very stony silt loam, 3 to 40 percent slopes	Severe: bedrock at depth of 12 to 20 inches; stones; slopes.	Severe: moderately slow permeability; slopes.	Severe: slopes
Woodburn silt loam, 0 to 3 percent slopes	Slight	Severe: slow permeability.	Slight
Woodburn silt loam, 3 to 12 percent slopes	Slight	Severe: slow permeability; slopes.	Slight
Woodburn silt loam, 12 to 20 percent slopes	Moderate: slopes	Severe: slow permeability; slopes.	Moderate: slopes

stated uses in town and country planning—Continued

Residential developments with sewage disposal by—Continued	Industrial development	Transportation	Recreational areas	
Sewage lagoons			Camping and picnicking	Paths and trails
Severe: too rocky	Severe: too rocky	Severe: too rocky	Severe: too rocky	Severe: too rocky.
Severe: steep slopes	Severe: steep slopes	Severe: steep slopes	Severe: steep slopes	Severe: steep slopes.
Moderate: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: poorly drained.	Severe: poorly drained.
Severe: flood hazard	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: poorly drained.	Severe: poorly drained.
Severe: slopes; bedrock at depth of 20 to 40 inches.	Severe: slopes; climate	Severe: slopes; bedrock at depth of 20 to 40 inches.	Moderate to severe: slopes.	Moderate: slopes.
Severe: slopes	Severe: slopes; climate	Severe: slopes	Severe: slopes	Severe: slopes.
Severe: slopes	Severe: slopes; climate	Severe: slopes	Severe: slopes	Severe: slopes.
Moderate: moderate permeability.	Slight	Slight	Slight	Slight.
Moderate: moderate permeability; severe on slopes stronger than 7 percent.	Slight	Slight	Slight to moderate: slopes.	Slight.
Severe: bedrock at depth of 12 to 20 inches.	Severe: slopes	Severe: slopes	Severe: slopes; stones	Severe: slopes; stones.
Slight	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Slight	Slight.
Moderate on slopes of 3 7 percent; severe on slopes stronger than 7 percent.	Moderate: seasonal high water table.	Moderate: seasonal high water table.	Moderate: slopes	Slight.
Severe: slopes	Moderate: slopes	Moderate: slopes	Severe: slopes	Moderate: slopes.

A rating of *severe* means that the soil has serious limitations that are costly to overcome and that the use of the soil for the intended purpose is questionable. Where a rating of moderate or severe is given, the chief limiting feature is identified.

Some of the main soil features that can limit the suitability of a soil for various town and country uses are low bearing capacity, susceptibility to erosion, susceptibility to frost action, and an inadequate percolation rate. Other important limiting features are bedrock near the surface, stones and boulders on and in the soil, unfavorable topography, and wetness.

Adequate bearing strength is important if a soil is to be used as a site for a building, a road, or a similar structure. When a soil is wet to a depth of 5 feet, its bearing strength may prove to be unsatisfactory for supporting a normal foundation for a structure of three stories or less. A normal foundation is one that has a maximum load distribution of about 2 tons per square foot.

A sloping soil is normally susceptible to accelerated erosion when it is used for clean-tilled crops. Gullying and sedimentation can also result if the vegetation is removed from a sloping soil that is to be used for residential or industrial development.

Susceptibility to frost action affects use of a soil for farming, roads, and many other uses. A soil that is susceptible to frost action undergoes a detrimental loss of strength as the result of freezing and thawing. The in-place material to a depth of 5 feet in such a soil is poorly suited to use as subgrade for a road. Susceptibiilty to frost action was not considered significant for any of the soils occurring at a low elevation.

An inadequate percolation rate is a limitation to use of a soil as a disposal field for the effluent from a septic tank. It can also affect some other uses.

Bedrock near the surface, or stones and boulders on and in the soil, are limitations to use of the soil for farming. They also interfere with the installation and proper functioning of a sewage disposal system. If a sewage disposal system is installed, contamination of the ground water can result.

Slopes, roughness of the terrain, and wetness are all limitations to use of a soil for some purposes. A sloping soil, for example, is not well suited to use as a filter field for disposing of effluent from a septic tank. A soil that is wet part or all of the time because of overflow or for some other reason is poorly suited to farming. Unless it can be drained and protected from flooding, such a soil is also poorly suited to use as a site for a building, as a site for recreational facilities, and for many other purposes.

In table 6 the soils in the Marion County Area are rated for a number of kinds of town and country uses. The ratings in the column titled "Farming" are mainly for soils used for the commercial production of small grains, vegetables, or other crops grown under an intensive level of management. Wetness, susceptibility to erosion, restricted drainage, strong slopes, stones, or inadequate available water capacity are among the features that limit use of soils for farming. All other soil features are less limiting than these.

Residential subdivisions in which sewage disposal is by septic tank refer to developments for homes, apartments, shopping centers, and other buildings of three stories or less that are dependent on septic tanks for disposal of sewage. The most limiting factors are low bearing strength, an inadequate percolation rate, unfavorable permeability, undesirable topography, wetness, or a combination of more than one of these features.

Residential subdivisions in which sewage disposal is by public sewer refer to developments for homes and other buildings of three stories or less that have access to public sewer. Low bearing strength, unfavorable topography, and wetness are the main features that limit a soil for this use, or a soil can have more than one of these limiting features.

Permeability of the soil, depth to an impervious layer, steepness of slope, hazard of flooding, and content of organic matter are all features that affect suitability of a soil for sewage lagoons.

Industrial development refers to construction requiring a level site on which a foundation is needed that is strong enough to bear the weight of a building three stories or less in height. The main soil features that limit use of soils for this use are low bearing strength, wetness, and unfavorable topography, or more than one of these limiting features may be present.

The ratings in the column titled "Transportation" are for use of soils for roads, for railroads, and for airports and their associated terminals. Soil features that limit use of the soils for transportation are unfavorable topography, wetness, susceptibility to frost action, and in-place suitability of soil material for road subgrade. Other soil features are less limiting than these.

In the category "Recreational areas used for camping and picnicking" are soils subjected to heavy foot traffic and to some vehicular traffic during the warm parts of the year. Soil features that severely limit soils for these uses are a seasonal high water table, frequent flooding or ponding, and slopes in excess of 12 percent. Other limiting features are poor drainage, unfavorable permeability or texture, and stoniness.

In the category "Recreational areas used for paths and trails" are soils used for trails, cross-country hiking, bridle paths, and other extensive recreational facilities. Features that severely limit the soils for these uses are a seasonal high water table, frequent flooding or ponding, and slopes in excess of 30 percent. Generally less limiting features are unfavorable soil texture and restricted natural drainage.

Descriptions of the Soils

This section describes the soil series and mapping units of the Marion County Area in alphabetical order. The procedure is first to describe each soil series, and then to describe the mapping units in that series. Thus, to get full information on any mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs.

The soil series contains a brief description of a soil profile, the major layers from the surface downward. This profile is considered typical for all the soils of the series. If the profile for a given mapping unit differs from this typical profile, the differences are stated in the description of the mapping unit, unless the differences are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Alluvial land, for example, does not belong to a soil series, but nevertheless, it is listed in alphabetical order along with the soil series.

A technical description typical for the soil series is given under the first mapping unit described for the series. The technical description identifies layers by A, B, C, and R horizons and depth ranges. These technical descriptions are mainly for soil scientists, engineers, and others who need to make a more thorough and precise study of the soils. The technical profile descriptions, and the paragraph describing range in characteristics that follows, are placed in smaller type than the rest of the description of the soil. Those who want to have only a working knowledge of the soil and its management need only read the part set in larger type.

In describing the typical profile, the color of each horizon is described in words, such as yellowish brown, but it can also be indicated by symbols for the hue, value, and chroma, such as 10YR 5/4. These symbols, called Munsell color notations (*13*), are used by soil scientists to evaluate the color of the soil precisely. For the profiles described, the names of the colors and the color symbols are for moist soil unless stated otherwise.

Following the name of each mapping unit, there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and the woodland group in which the mapping unit has been placed. The page on which each group is described can be found by referring to the "Guide to Mapping Units" at the back of this survey. Many terms in the soil descriptions

TABLE 7.—*Approximate acreage and proportionate extent of the soils*

Mapping unit	Acres	Percent	Mapping unit	Acres	Percent
Abiqua silty clay loam, 0 to 3 percent slopes	1, 060	0. 2	McCully clay loam, 50 to 70 percent slopes	9, 395	1. 7
Abiqua silty clay loam, 3 to 5 percent slopes	408	. 1	McCully stony clay loam, 2 to 20 percent slopes	545	. 1
Alluvial land	2, 790	. 5	McCully very stony clay loam, 2 to 30 percent slopes	2, 615	. 5
Amity silt loam	45, 109	8. 3	Minniece silty clay loam, 0 to 8 percent slopes	700	. 1
Bashaw clay	4, 830	. 9	Nekia silty clay loam, 2 to 7 percent slopes	23, 955	4. 4
Camas gravelly sandy loam	5, 815	1. 1	Nekia silty clay loam, 7 to 12 percent slopes	17, 530	3. 2
Chehalem silt loam, 2 to 12 percent slopes	350	. 1	Nekia silty clay loam, 12 to 20 percent slopes	13, 648	2. 5
Chehalis silty clay loam	5, 730	1. 1	Nekia silty clay loam, 20 to 30 percent slopes	7, 210	1. 3
Clackamas gravelly loam	10, 430	1. 9	Nekia silty clay loam, 30 to 50 percent slopes	8, 448	1. 6
Cloquato silt loam	20, 165	3. 7	Nekia stony silty clay loam, 2 to 12 percent slopes	959	. 2
Concord silt loam	14, 980	2. 7	Nekia very stony silty clay loam, 2 to 30 percent slopes	2, 005	. 4
Courtney gravelly silty clay loam	4, 850	. 9	Nekia very stony silty clay loam, 30 to 50 percent slopes	2, 910	. 5
Cumley silty clay loam, 2 to 20 percent slopes	2, 408	. 4	Newberg fine sandy loam	6, 895	1. 3
Dayton silt loam	10, 440	1. 9	Newberg silt loam	4, 668	. 9
Hazelair silt loam, 2 to 6 percent slopes	859	. 2	Salem gravelly silt loam	5, 640	1. 0
Hazelair silt loam, 6 to 20 percent slopes	750	. 1	Salkum silty clay loam, 2 to 6 percent slopes	1, 467	. 3
Hazelair silty clay loam, 2 to 15 percent slopes, eroded	605	. 1	Salkum silty clay loam, 6 to 20 percent slopes	420	. 1
Henline very stony sandy loam, 6 to 30 percent slopes	1, 070	. 2	Salkum silty clay loam, basin, 0 to 6 percent slopes	4, 977	. 9
Henline very stony sandy loam, 30 to 55 percent slopes	2, 640	. 5	Santiam silt loam, 0 to 3 percent slopes	330	. 1
Henline very stony sandy loam, 55 to 80 percent slopes	5, 625	1. 0	Santiam silt loam, 3 to 6 percent slopes	1, 100	. 2
Holcomb silt loam	2, 430	. 4	Santiam silt loam, 6 to 15 percent slopes	260	(1)
Horeb loam, 2 to 20 percent slopes	6, 640	1. 2	Semiahmoo muck	1, 190	. 2
Horeb gravelly silt loam, gravelly substratum, 0 to 15 percent slopes	2, 440	. 4	Sifton gravelly loam	6, 450	1. 2
Horeb gravelly silt loam, gravelly substratum, 15 to 35 percent slopes	3, 450	. 6	Silverton silt loam, 2 to 12 percent slopes	2, 517	. 5
Hullt clay loam, 2 to 7 percent slopes	215	(1)	Silverton silt loam, 12 to 20 percent slopes	269	(1)
Hullt clay loam, 7 to 20 percent slopes	420	. 1	Stayton silt loam, 0 to 7 percent slopes	1, 710	. 3
Hullt clay loam, 2 to 20 percent slopes	280	(1)	Steiwer silt loam, 3 to 6 percent slopes	457	. 1
Hullt clay loam, 20 to 30 percent slopes	1, 629	. 3	Steiwer silt loam, 6 to 20 percent slopes	1, 150	. 2
Hullt clay loam, 30 to 60 percent slopes	2, 030	. 4	Steiwer and Chehulpum silt loams, 3 to 40 percent slopes	3, 318	. 6
Jory silty clay loam, 2 to 7 percent slopes	9, 970	1. 8	Stony rock land	720	. 1
Jory silty clay loam, 7 to 12 percent slopes	7, 425	1. 4	Terrace escarpments	4, 439	. 8
Jory silty clay loam, 12 to 20 percent slopes	3, 709	. 7	Waldo silty clay loam	3, 380	. 6
Jory silty clay loam, 20 to 30 percent slopes	995	. 2	Wapato silty clay loam	11, 008	2. 0
Kinney cobbly loam, 2 to 20 percent slopes	11, 020	2. 0	Whetstone stony loam, 3 to 25 percent slopes	2, 610	. 5
Kinney cobbly loam, 20 to 50 percent slopes	22, 395	4. 1	Whetstone stony loam, 25 to 55 percent slopes	7, 720	1. 4
Kinney cobbly loam, 50 to 70 percent slopes	3, 725	. 7	Whetstone stony loam, 55 to 75 percent slopes	9, 030	1. 7
Labish silty clay loam	1, 130	. 2	Willamette silt loam, 0 to 3 percent slopes	9, 730	1. 8
McAlpin silty clay loam, 0 to 3 percent slopes	6, 930	1. 3	Willamette silt loam, 3 to 12 percent slopes	1, 270	. 2
McAlpin silty clay loam, 3 to 6 percent slopes	1, 640	. 3	Witzel very stony silt loam, 3 to 40 percent slopes	1, 950	. 4
McBee silty clay loam	3, 750	. 7	Woodburn silt loam, 0 to 3 percent slopes	61, 230	11. 2
McCully clay loam, 2 to 7 percent slopes	7, 970	1. 5	Woodburn silt loam, 3 to 12 percent slopes	9, 577	1. 8
McCully clay loam, 7 to 12 percent slopes	4, 900	. 9	Woodburn silt loam, 12 to 20 percent slopes	4, 490	. 8
McCully clay loam, 12 to 20 percent slopes	3, 610	. 7			
McCully clay loam, 20 to 30 percent slopes	2, 565	. 5			
McCully clay loam, 2 to 30 percent slopes	6, 950	1. 3			
McCully clay loam, 30 to 50 percent slopes	25, 855	4. 7	Total	544, 879	100. 0

[1] Less than 0. 05 percent.

are defined in the Glossary. The acreage and proportionate extent of the mapping units are shown in table 7. The location of the soils in the Marion County Area is shown on the detailed soil map at the back of this survey.

Abiqua Series

The Abiqua series consists of well-drained soils that have formed in alluvium. These soils have slopes of 0 to 5 percent. They occur on low foothills, along small streams and in drainageways, at elevations of 250 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, native grasses, and shrubs. Abiqua soils are associated with McAlpin and Waldo soils.

In a typical profile, the surface layer is very dark brown silty clay loam about 6 inches thick. The subsurface layer is also very dark brown silty clay loam and is about 15 inches thick. The upper part of the subsoil is dark reddish-brown silty clay that extends to a depth of about 54 inches. The lower part of the subsoil is dark-brown silty clay loam that extends to a depth of 72 inches or more.

The Abiqua soils are used mainly for small grains, grass grown for seed, orchards, and pastures. When irrigated, they are used for other crops.

Abiqua silty clay loam, 0 to 3 percent slopes (AbA).—This soil is along streams and in drainageways of the Salem and Waldo Hills. The areas are small.

Representative profile 85 feet east and 60 feet south of road intersection (in the corner of SW¼SW¼NE¼ sec. 2, T. 9 S., R. 1 W.):

Ap—0 to 6 inches, very dark brown (10YR 2/2) silty clay loam, dark brown (7.5YR 3/2) when dry; moderate, very fine, granular structure; friable, hard, slightly plastic and slightly sticky; many roots; many interstitial pores; medium acid (pH 5.8); abrupt, smooth boundary. (5 to 7 inches thick.)

A3—6 to 21 inches, very dark brown (10YR 2/2) silty clay loam, dark brown (7.5YR 3/2) when dry; moderate, fine and very fine, subangular blocky structure; firm, hard, plastic and sticky; many roots; many, fine, tubular pores; thin, patchy, darker colored coatings on ped surfaces; medium acid (pH 5.6); clear, smooth boundary. (13 to 17 inches thick.)

B21—21 to 36 inches, dark reddish-brown (5YR 2/2) silty clay, dark reddish brown (5YR 3/4) when dry; weak, prismatic structure breaking to moderate, medium, subangular blocky structure; firm, very hard, very plastic and very sticky; common roots; many, fine and very fine, tubular pores; thin, continuous, slightly darker colored coatings on ped surfaces; strongly acid (pH 5.4); diffuse, smooth boundary. (10 to 20 inches thick.)

B22—36 to 54 inches, dark reddish-brown (5YR 3/2) silty clay, reddish brown (5YR 4/4) when dry; very weak, prismatic structure breaking to moderate, medium, subangular blocky structure; firm, very hard, very plastic and very sticky; few roots; many, fine and very fine, tubular pores; thin, continuous, dark reddish-brown (5YR 3/4) coatings on ped surfaces when dry; common, fine and very fine fragments of weathered rock; strongly acid (pH 5.3); diffuse, smooth boundary. (13 to 23 inches thick.)

B3—54 to 72 inches, dark-brown (7.5YR 3/2) silty clay loam, reddish brown (5YR 4/3) when dry; moderate, medium, subangular blocky structure; firm, hard, plastic and sticky; very few roots; many, fine and very fine, tubular pores; many fine and very fine fragments of weathered rock; strongly acid (pH 5.3).

Color of the A horizon is dark brown or very dark brown, and texture of that horizon ranges from silt loam to silty clay loam. Color of the B horizon ranges from dark brown to dark reddish brown. Texture of the B horizon ranges from silty clay to clay, except that the B3 horizon is silty clay loam in many places. In some areas a few angular pebbles are scattered throughout the profile.

Included with this soil in mapping were small areas that contain a layer of gravel below a depth of 40 inches. Also included were small areas of McAlpin and Waldo soils.

The available water capacity is 10 to 11 inches, permeability is moderately slow, and fertility is moderate. Runoff is slow, and the hazard of erosion is only slight. Where additions of organic matter are regularly supplied, workability of this soil is good. Depth to which roots can penetrate is not restricted.

This soil is used mainly for small grains, grass grown for seed, orchards, and pasture, but small areas are still in Douglas-fir. When this soil is irrigated, it is used for most of the crops commonly grown in the survey area. It is well suited to most crops, but it is not well suited to potatoes and carrots. (Capability unit I–1; not placed in a woodland suitability group)

Abiqua silty clay loam, 3 to 5 percent slopes (AbB).—This soil has a profile similar to the one described for Abiqua silty clay loam, 0 to 3 percent slopes, except that material washed from higher slopes has been deposited on the surface in a few places. Runoff is medium, and the hazard of erosion is slight.

This soil is used for about the same crops as Abiqua silty clay loam, 0 to 3 percent slopes. (Capability unit IIe–2; not placed in a woodland suitability group)

Alluvial Land

Alluvial land (Ad) occurs mostly along the Santiam, North Santiam, and Willamette Rivers, on or near the bed of the main stream, in overflow channels, and on islands or bars. It consists mostly of loose sand, gravel, and cobblestones, but it includes some small areas of silt loam. This material is frequently shifted by floodwaters, for this land type is subject to overflow in winter and spring.

In places this land type supports a good stand of cottonwoods, but use of these trees for timber is restricted by the very severe hazard of erosion if the trees are cut. Other areas have a cover of Douglas-fir. Still other small areas are bare, except for scattered willows. (Capability unit VIIw–1; not placed in a woodland suitability group)

Amity Series

The Amity series consists of somewhat poorly drained soils that have formed in mixed alluvial silts. These soils have slopes of 0 to 2 percent. They occur on broad valley terraces at elevations of 150 to 350 feet. The average annual precipitation is between 40 and 45 inches. The average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly grasses, shrubs, hardwoods, and scattered Douglas-firs. Amity soils are associated with Dayton and Concord soils.

In a typical profile, the surface layer is very dark grayish-brown silt loam that is mottled in the lower part and is about 17 inches thick. The subsurface layer is mottled dark-gray silt loam about 7 inches thick. The subsoil is mottled grayish-brown silty clay loam about 13 inches thick. A substratum of mottled olive-brown silt loam underlies the subsoil.

The Amity soils are used mainly for cereal grains, grass grown for seed, and pasture. When irrigated, areas that are drained can be used for all the crops commonly grown in the survey area.

Amity silt loam (Am).—This is the only soil of the Amity series mapped in the survey area. It occupies slightly convex or nearly level areas on terraces consisting of Willamette silts.

Representative profile 30 feet east of a paved road (SW¼SE¼ sec. 10, T. 5 S., R. 2 W.):

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; abundant fine roots; many interstitial pores; medium acid (pH 6.0); clear, smooth boundary. (5 to 8 inches thick.)

A1—7 to 17 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; common, fine, faint, reddish-brown mottles; moderate, medium, subangular blocky structure; friable, hard, slightly sticky and slightly plastic; abundant fine roots; common interstitial pores and few, fine and medium, tubular pores; common, fine and medium, reddish-brown concretions; medium acid (pH 6.0); clear, smooth boundary. (5 to 10 inches thick.)

A2—17 to 24 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) when dry; common, fine, faint, reddish-brown mottles; weak, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; common fine roots; common interstitial pores and common, fine and medium, tubular pores; common, fine and medium, brown concretions; medium acid (pH 6.0); clear, wavy boundary. (4 to 8 inches thick.)

B21t—24 to 29 inches, grayish-brown (2.5Y 5/2) silty clay loam, light brownish gray (10YR 6/2 when dry; common, fine, distinct, reddish-brown mottles; weak, medium, prismatic structure breaking to moderate, coarse, subangular blocky structure; friable, hard, sticky and plastic; few fine roots; common, medium, tubular pores; thin, patchy clay films in pores, on vertical surfaces of peds, and on some horizontal surfaces of peds; common, fine, red and black concretions; slightly acid (pH 6.2); gradual, wavy boundary. (4 to 9 inches thick.)

B22t—29 to 37 inches, grayish-brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) when dry; common, fine, distinct, light yellowish-brown and black mottles; weak, medium, prismatic structure breaking to moderate, coarse, subangular blocky structure; friable, hard, sticky and plastic; few fine roots; few, medium and fine, tubular pores; thin, patchy clay films in pores and on vertical and horizontal surfaces of peds; many, fine, reddish-brown and few, fine, black concretions; slightly acid (pH 6.2); diffuse boundary. (5 to 14 inches thick.)

C—37 to 60 inches, olive-brown (2.5Y 4/4) silt loam, light yellowish brown (2.5Y 6/4) when dry; common, fine, faint, brown mottles; massive; friable, hard, slightly sticky and slightly plastic; few fine roots; few fine and medium pores; thick clay films in pores; slightly acid (pH 6.4).

When the soil is moist, color of the A horizon ranges from dark brown to very dark grayish brown. Texture of the B horizon is heavy silt loam in some areas, and the structural grade of that horizon is moderate in places. In some places the lower part of the B horizon is weakly to moderately brittle. Bedrock is at a depth of more than 60 inches.

Included with this soil is mapping were small areas of soils that are in drainageways and depressions and that have slopes of 2 to 5 percent. Also included were small areas of Woodburn and Concord soils.

The available water capacity ranges from 9 to 12 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and erosion is not a hazard or is only a slight hazard. The depth to which roots can penetrate is moderately restricted by wetness, partly caused by a high water table that is near the surface during winter and spring. Workability is good, but this soil compacts easily if it is cultivated when wet.

Undrained areas of this soil are used for small grains, pasture, and grasses grown for seed, but drainage is needed for berries, vegetables, and specialty crops. If this soil is drained and irrigated, it can be used for all the crops commonly grown in the survey area. Even after drainage is installed, however, there are slight restrictions to use of this soil for deep-rooted crops that cannot tolerate excessive moisture. Nevertheless, response to drainage and fertilizer is generally good. (Capability unit IIw-2; not placed in a woodland suitability group)

Bashaw Series

The Bashaw series consists of poorly drained and very poorly drained soils that have formed in alluvium. These soils are in backwater areas of the flood plains and in drainage channels of silty alluvial terraces. They have slopes of 0 to 1 percent. Elevations range from 100 to 400 feet. The average annual precipitation is between 40 and 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly annual and perennial grasses, wild blackberries, sedges, rushes, willows, and a few ash and oak trees. Bashaw soils are associated with Wapato soils.

In a typical profile, the surface layer is about 31 inches thick and consists of mottled very dark gray clay in the uppermost 3 inches and of mottled black clay below. The upper part of the substratum, just beneath the surface layer, is very dark gray clay that extends to a depth of 48 inches. The lower part of the substratum is dark grayish-brown clay or sandy clay that extends to a depth of 60 inches or more. The substratum is mottled throughout.

The Bashaw soils are used mainly for pasture.

Bashaw clay (Ba).—This is the only soil of the Bashaw series mapped in the survey area. It occupies concave backwater areas adjacent to silty alluvial terraces, and it is also in drainage channels on the terraces. The areas are small.

Representative profile (NW¼SW¼NE¼ sec. 9, T. 6 S., R. 1 W.):

A11—0 to 3 inches, very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) when dry; many, fine, distinct, yellowish-red (5YR 4/6) mottles; moderate, medium and fine, subangular blocky structure; firm, very hard, very sticky and very plastic; common roots; many very fine pores; medium acid (pH 5.8); abrupt, smooth boundary. (0 to 4 inches thick.)

A12g—3 to 14 inches, black (N 2/0) clay, very dark gray (N 3/0) when dry; few, fine, distant, yellowish-red (5YR 5/6) mottles; massive when wet; weak, coarse, prismatic structure breaking to weak, coarse, angular blocky structure when moist or dry; very firm, very hard, very sticky and very plastic; common very fine roots; many very fine pores; common, fine, red and black concretions; few small slickensides; medium acid (pH 6.0); clear, smooth boundary. (6 to 15 inches thick.)

A13g—14 to 31 inches, black (N 2/0) clay, very dark gray (N 3/0) when dry; few, fine, distant, yellowish-red (5YR 4/6) mottles; massive; very firm, very hard, very plastic and very sticky; few slickensides; few very fine roots; few very fine pores; common, fine, red and black concretions; neutral (pH 6.6); gradual, smooth boundary. (14 to 20 inches thick.)

C1g—31 to 48 inches, very dark gray (N 3/0) clay, dark gray (N 4/0) when dry; common, medium, faint, light olive-brown (2.5Y 5/6) mottles; massive; very firm, very hard, very sticky and very plastic; common large slickensides; common, fine, light-colored fragments; few roots; few very fine pores; neutral (pH 7.0); abrupt, smooth boundary. (10 to 20 inches thick.)

C2g—48 to 60 inches, dark grayish-brown (2.5Y 4/2) clay or sandy clay, light brownish gray (2.5Y 6/2) when dry; many, medium, distinct, dark-brown (7.5YR 3/2) and dark reddish-brown (5YR 3/2) mottles and few, medium, faint, dark-gray (N 4/0) mottles; massive; firm, very hard, sticky and plastic; no roots; common very fine pores; neutral (pH 7.0).

When this soil is moist, the A12g and A13g horizons are generally black, but their color ranges to very dark gray in some areas. In the uppermost 3 to 4 inches of the soil profile, the structure is weak to strong granular or very fine subangular blocky. Texture in the uppermost 3 to 8 inches of the profile ranges from clay to silty clay or silty clay loam. The soil material between depths of 8 and 40 inches is more than 60 percent clay. Reaction ranges from neutral to medium acid in the uppermost 10 to 15 inches of the profile, and it is slightly acid to neutral below.

Included with this soil in mapping were small areas of moderately fine textured soils that have a very dark grayish-brown surface layer. Also included were areas of clayey soils that have a thin, black surface layer.

The available water capacity ranges from 8 to 10 inches. Permeability is very slow, and fertility is moderate. Runoff is very slow to ponded, and the hazard of erosion is slight. Some material is deposited on the surface each year in areas not protected and not drained. Workability is poor. Because of the annual high water table and the very fine texture of the soil material, only a few roots penetrate to depths greater than 31 inches, but roots can penetrate to a depth of about 48 inches.

This soil is used mainly for pasture, but it can be used for spring barley, wheat, improved pasture, and hay if surface drainage is provided. Although drainage is needed, outlets are generally inadequate for surface drainage, and this soil is unsuitable for tile drains, because of its fine texture and very slow permeability. For only short periods is it dry enough to cultivate. (Capability unit IVw-2; not placed in a woodland suitability group)

Camas Series

The Camas series consists of excessively drained soils that formed in recent alluvium derived mainly from basic igneous and sedimentary rocks. These soils have slopes of 0 to 3 percent. They occur on bottom lands of the large streams. Elevations range from 125 to 500 feet. The average annual precipitation is between 40 and 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly ash, oak, alder, rose, blackberry, annual weeds, and grasses. Camas soils are associated with Newberg and Cloquato soils.

In a typical profile, the surface layer is dark-brown gravelly sandy loam about 9 inches thick. The substratum, just beneath the surface layer, is dark yellowish-brown very gravelly sand that extends to a depth of 60 inches or more.

The Camas soils are used mainly for small grains, for pasture, or as woodland. When irrigated, they are used for all the crops commonly grown in the survey area.

Camas gravelly sandy loam (Ca).—This soil occupies small areas along Butte Creek and the Willamette, North Santiam, and Santiam Rivers. It is the only soil of the Camas series mapped in the survey area.

Representative profile (SW¼SE¼ sec. 11, T. 9 S., R. 1 W.):

A1—0 to 9 inches, dark-brown (10YR 3/3) gravelly sandy loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; friable, slightly hard, nonsticky and nonplastic; many roots; many, fine, interstitial pores; slightly acid (pH 6.1); gradual, smooth boundary. (7 to 11 inches thick.)

C—9 to 60 inches, dark yellowish-brown (10YR 4/4) very gravelly sand, light yellowish brown (10YR 6/4) when dry; single grain; loose, nonsticky and nonplastic; common roots; many interstitial pores; medium acid (pH 6.0).

When the soil is moist, color of the A horizon ranges from very dark grayish brown to dark brown. Texture of the A horizon ranges from silt loam to loamy sand, and texture of the C horizon ranges from very gravelly loamy sand to very gravelly sand or cobbly sand. More than 50 percent of the C horizon, by volume, is coarse fragments. Reaction of the A horizon ranges from neutral to medium acid. Reaction of the C horizon ranges from medium acid to slightly acid.

Included with this soil in mapping were small cobbly areas and other small areas that have a surface layer of silt loam.

The very gravelly or cobbly substratum near the surface restricts the available water capacity, which is 3 inches or less. It also restricts the depth to which roots can penetrate. Permeability is very rapid, and fertility is low. Runoff is very slow, and erosion is generally only a slight hazard. Areas adjacent to streams are moderately susceptible to erosion because they are usually flooded at least once each year. Workability is poor.

This soil is used mainly for small grains, for pasture, or as woodland. When irrigated, it is used for all the crops commonly grown in the survey area, although it is poorly suited to root crops and to many other crops. (Capability unit IVw-3; not placed in a woodland suitability group)

Chehalem Series

The Chehalem series consists of somewhat poorly drained soils that have formed in alluvium. These soils have slopes of 2 to 12 percent. They occur on alluvial fans at elevations of 150 to 300 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In noncultivated areas the vegetation is mainly ash, cottonwood, willow, oak, sedges, reeds, and grasses. Chehalem soils are associated with Woodburn soils.

In a typical profile, the surface layer is very dark brown silt loam about 16 inches thick. The subsoil is mottled silty clay about 44 inches thick. The upper part of the subsoil is very dark grayish brown, the middle part is dark grayish brown, and the lower part is olive brown.

The Chehalem soils are used mainly for small grains, pasture, hay, and native hardwoods. When irrigated, a small acreage is used for vegetables, improved pasture, and caneberries.

Chehalem silt loam, 2 to 12 percent slopes (CeC).—This is the only soil of the Chehalem series mapped in the survey area. It occupies small areas on foot slopes of the Salem and Waldo Hills.

Representative profile (SE¼SW¼ sec. 23, T. 9 S., R. 3 W.):

Ap—0 to 8 inches, very dark brown (10YR 2/2) heavy silt loam, very dark grayish brown (10YR 3/2) when dry; moderate, coarse, subangular blocky structure; friable, hard, sticky and plastic; common roots; many, fine, tubular pores; medium acid (pH 5.8); clear, smooth boundary. (6 to 8 inches thick.)

A1—8 to 16 inches, very dark brown (10YR 2/2) heavy silt loam, very dark grayish brown (10YR 3/2) when dry; moderate, coarse, subangular blocky structure breaking to fine, subangular blocky structure; friable, hard, sticky and plastic; common roots; many, fine, tubular pores; medium acid (pH 5.6); abrupt, smooth boundary. (4 to 8 inches thick.)

B21—16 to 31 inches, very dark grayish-brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) when dry; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium and coarse, subangular blocky structure; firm, very hard, very sticky and very plastic; few roots; many, very fine, tubular pores; medium acid (pH 5.6); gradual, smooth boundary. (6 to 15 inches thick.)

B22—31 to 42 inches, dark grayish-brown (2.5Y 4/2) silty clay, light yellowish brown (2.5Y 6/4) when dry; many, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, prismatic structure; very firm, extremely hard, very sticky and very plastic; few roots; common, fine, tubular pores; many particles the size of fine shot; medium acid (pH 5.8); gradual, smooth boundary. (8 to 15 inches thick.)

IIB3—42 to 60 inches, olive-brown (2.5Y 4/4) silty clay, light olive brown (2.5Y 5/4) when dry; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, coarse, prismatic and weak, coarse, angular blocky structure; very firm, extremely hard, sticky and plastic; few roots; common, fine, tubular pores; many manganese stains; many sand-size fragments of rock; medium acid (pH 6.0).

Texture of the A horizon ranges from silt loam to clay loam or silty clay loam. In places the A horizon is dark brown. Color of the B2 horizons ranges from very dark brown to dark grayish brown or very dark grayish brown, and mottling in those horizons ranges from faint to distinct. Weathered coarse fragments of sedimentary rock are common throughout the profile. They make up as much as 40 percent of the lower B horizons. In places the profile also contains fragments of basalt.

Included with this soil in mapping were small areas of a soil along Butte Creek that has a lighter colored surface layer and a more permeable subsoil than this soil. The subsoil of the included soil is silty clay loam.

The available water capacity is 10 to 11 inches. Permeability is slow, and fertility is moderate. Runoff is medium, and the hazard of erosion is slight. This soil is subject to seepage and runoff from higher areas. The depth to which roots can penetrate is restricted by wetness during winter and spring. Workability is fair.

This soil is used mainly for small grains, pasture, hay, and native hardwoods. When irrigated, a small acreage is used for vegetables, improved pasture, and caneberries. (Capability unit IIIe-5; not placed in a woodland suitability group)

Chehalis Series

The Chehalis series consists of well-drained soils that have formed in alluvium. These soils are nearly level or gently undulating, and they occur on bottom lands that are traversed by old overflow channels and sloughs. Elevations range from 100 to 650 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is about 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly alder, ash, bigleaf maple, oak, and an understory of vine maple, wild blackberry, vines, and shrubs. Chehalis soils are associated with Cloquato and Newberg soils.

In a typical profile, the surface layer is dark-brown silty clay loam about 9 inches thick. The subsoil is also dark-brown silty clay loam and is about 28 inches thick. The substratum is silty clay loam that is dark brown in the upper part and dark yellowish brown in the lower part. It extends to a depth of 80 inches or more.

The Chehalis soils are used mainly for pasture, hay, cereal grains, grass grown for seed, and orchards. When irrigated, they are used extensively for vegetables and berries.

Chehalis silty clay loam (Ch).—This is the only soil of the Chehalis series mapped in the survey area. It occupies the higher parts of bottom lands along the larger streams. Overflow occurs only about once in 50 years.

Representative profile (W½SE¼NE¼ sec. 20, T. 6 S., R. 1 W.):

Ap—0 to 9 inches, dark-brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) when dry; weak, fine, subangular blocky structure; friable, slightly hard, sticky and plastic; many roots; many fine pores; slightly acid (pH 6.6); abrupt, smooth boundary. (6 to 10 inches thick.)

B2—9 to 37 inches, dark-brown (10YR 3/3) silty clay loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; friable, slightly hard, sticky and plastic; many roots; many very fine and fine pores; slightly acid (pH 6.4); gradual, smooth boundary. (22 to 40 inches thick.)

C1—37 to 63 inches, dark-brown (10YR 3/3) silty clay loam, dark grayish brown (10YR 4/2) when dry; weak, medium, subangular blocky structure; friable, slightly hard, sticky and plastic; few roots; many very fine and fine pores; slightly acid (pH 6.4); gradual, smooth boundary.

C2—63 to 80 inches, dark yellowish-brown (10YR 3/4) silty clay loam, dark grayish brown (10YR 4/2) when dry; massive; friable, slightly hard, sticky and plastic; many fine pores; slightly acid (pH 6.4).

Texture of the Ap horizon is dominantly silty clay loam, but it ranges to heavy silt loam.

Included with this soil in mapping were small areas of Cloquato, Newberg, and Camas soils, and small areas of a steep soil on breaks.

The available water capacity is 11 to 12 inches. Permeability is moderate, and fertility is high. Runoff is slow, and the hazard of erosion is slight. Depth to which roots can penetrate is not restricted. This soil is generally in good tilth if regular additions of organic matter are provided.

This soil is used mainly for pasture, hay, cereal grains, grass grown for seed, and orchards. When irrigated, it is used extensively for vegetables and berries, but it is also used for all the crops commonly grown in the survey area, except potatoes and carrots. (Capability unit I–1; not placed in a woodland suitability group)

Chehulpum Series

The Chehulpum series consists of well-drained soils formed in mixed material that contains loess and is underlain by sandstone or shale. Bedrock is within 20 inches of the surface. These soils have slopes of 3 to 40 percent. They occur on foot slopes and on low foothills at elevations of 300 to 650 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. The vegetation is mainly oak, poison-oak, wild rose, and grasses. Chehulpum soils are associated with Steiwer soils.

In a typical profile, the surface layer is very dark brown silt loam about 12 inches thick. This is covered with a thin layer of decomposing grass and leaves. The underlying bedrock, at a depth of about 12 inches, is horizontally bedded, fine-grained sandstone.

The Chehulpum soils are used mostly for pasture.

In this survey area, the Chehulpum soils were mapped only in an undifferentiated unit with Steiwer soils. A detailed technical profile of a Chehulpum soil is described in the Steiwer series under Steiwer and Chehulpum silt loams, 3 to 40 percent slopes.

Clackamas Series

The Clackamas series consists of somewhat poorly drained soils that have formed in gravelly mixed alluvium. These soils have slopes of 0 to 3 percent. They occur on terraces at elevations of 175 to 650 feet. The average annual precipitation is between 40 and 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, hazel, brackenfern, wild rose, and grasses. Clackamas soils are associated with Sifton and Salem soils.

In a typical profile, the surface layer is very dark grayish-brown gravelly loam about 6 inches thick. The subsurface layer is also very dark grayish-brown gravelly loam, and it is about 9 inches thick. The subsoil is mottled very dark gray and dark reddish-brown gravelly clay loam about 9 inches thick. The substratum is mottled. It consists of dark-brown and strong-brown very gravelly clay loam that extends to a depth of 60 inches or more.

Clackamas soils that are neither drained nor irrigated are used mainly as woodland and for pasture, hay, and cereal grains. When irrigated, the drained areas are used for pole beans, bush beans, sweet corn, berries, squash, and cucumbers.

Clackamas gravelly loam (Ck).—This is the only soil of the Clackamas series mapped in the survey area. It is on terraces between Stayton, Jefferson, and Salem, and along Abiqua Creek, northeast of Silverton. The areas are of medium size.

Representative profile 50 feet east of a paved road (NE¼SE¼ sec. 1, T. 8 S., R. 3 W.):

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) gravelly loam, dark grayish brown (10YR 4/2) when dry; moderate, medium and fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many very fine and fine pores; medium acid (pH 5.6); abrupt, smooth boundary. (5 to 7 inches thick.)

A3—6 to 15 inches, very dark grayish-brown (10YR 3/2) gravelly loam, dark grayish brown (10YR 4/2) and brown (10YR 4/3) when dry; common, fine and medium, black and reddish-brown mottles; moderate, medium, subangular blocky structure; friable, hard, slightly sticky and slightly plastic; many roots; many, very fine and fine, tubular pores; common, fine (1 millimeter in diameter), light-colored fragments; medium acid (pH 5.8); clear, smooth boundary. (7 to 11 inches thick.)

B2tg—15 to 24 inches, mottled very dark gray (10YR 3/1) and dark reddish-brown (2.5YR 3/4) gravelly clay loam, grayish brown (10YR 5/2) and yellowish red (5YR 5/6) when dry; moderate, medium, subangular blocky structure; friable, hard, sticky and plastic; many roots; many fine and medium pores; common moderately thick clay films in pores and on the surfaces of pebbles, and a few on the surfaces of peds; medium acid (pH 5.6); abrupt, smooth boundary. (8 to 10 inches thick.)

IICg—24 to 60 inches, mottled dark-brown (10YR 3/3) and mottled strong-brown (7.5YR 5/6) very gravelly clay loam, light brownish gray (10YR 6/2), pale brown (10YR 6/3), and light yellowish brown (10YR 6/4) when dry; massive; firm, very hard, slightly sticky and slightly plastic; few pores; 80 to 90 percent gravel and cobblestones; strongly acid (pH 5.4).

Color of the A horizon ranges from black to very dark grayish brown. Color of the B horizon is highly variegated. In places texture in the lower part of the B horizon ranges to very gravelly light silty clay. Depth to the gravelly lower part of the B horizon or to the very gravelly C horizon ranges from 20 to 36 inches.

Included with this soil in mapping were small areas of Courtney soils and small areas that have a surface layer of clay loam. These included areas make up as much as 15 percent of the acreage in the mapping unit.

The available water capacity is 4 to 5 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and the hazard of erosion is only slight. This soil has a seasonal high water table. In some irrigated areas, there is a permanent high water table as the result of overirrigation and seepage from irrigation ditches. Depth to which roots can penetrate is restricted to about 24 inches by the compact, very gravelly substratum. Workability is poor.

Areas of this soil that are neither drained nor irrigated are used for pasture, hay, and cereal grains, and they are also used as woodland. Areas that are drained are used for pole beans, bush beans, sweet corn, berries, squash, and cucumbers when they are irrigated. If this soil is irrigated and properly fertilized, it is well suited to all the commonly grown crops. (Capability unit IIIw–1; not placed in a woodland suitability group)

Cloquato Series

The Cloquato series consists of well-drained soils that have formed in alluvium. These soils are nearly level and gently undulating, and they are on flood plains of the major streams. The areas are traversed by overflow channels and sloughs. Elevations range from 100 to 650 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, cottonwood, bigleaf maple, Oregon white oak, ash, and an understory of vine maple, wild blackberry, vines, shrubs, and grasses. Cloquato soils are associated with Chehalis and Newberg soils.

In a typical profile, the surface layer is dark-brown silt loam about 9 inches thick. The subsoil, which is also dark-brown silt loam, is about 56 inches thick. The substratum is dark-brown fine sandy loam that extends to a depth of 83 inches or more.

Cloquato soils that are not irrigated are used mainly for small grains, orchards, pasture, hay, and grass grown for seed. When irrigated, these soils are used for all the crops commonly grown in the survey area.

Cloquato silt loam (Cm).—This is the only Cloquato soil mapped in the survey area. It occupies large areas along the Willamette, Pudding, and Santiam Rivers and along Butte Creek.

Representative profile (E½SE¼ sec. 20, T. 6 S., R. 1 W.):

Ap—0 to 9 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, medium and coarse, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many, fine and very fine, tubular pores; medium acid (pH 6.0); clear, smooth boundary. (6 to 10 inches thick.)

B2—9 to 41 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; common roots; many, very fine, tubular pores; slightly acid (pH 6.2); gradual, smooth boundary. (15 to 35 inches thick.)

B3—41 to 65 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; very weak, coarse, subangular blocky structure; very friable, slightly hard, slightly sticky and nonplastic; few roots; many, fine, tubular pores; slightly acid (pH 6.4); clear, smooth boundary. (0 to 25 inches thick.)

C—65 to 83 inches, dark-brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) when dry; massive; very friable, soft, nonsticky and nonplastic; no roots; many fine pores; slightly acid (pH 6.4).

Texture of the B2 horizon is dominantly silt loam, but this horizon contains thin layers of sandy material in places. This sandy material is generally below a depth of 30 inches.

Included with this soil in mapping were small areas of Chehalis, Newberg, and Camas soils, and small areas in which the substratum is gravelly. Also included were areas of steeper soils that have short slopes and that are adjacent to sloughs and old stream channels. The included areas make up from 10 to 15 percent of the acreage in this mapping unit.

The available water capacity is 12 to 14 inches. Permeability is moderate, and fertility is high. Runoff is slow, but the hazard of erosion is slight to moderate as the result of periodic overflow. Overflow generally occurs about once in 3 or 4 years, but it occurs two or more times in some years. Roots can penetrate to a depth of 5 feet or more. Workability is very good.

This soil is used mainly for small grains, orchards, pasture, hay, and grass grown for seed. When irrigated, it is used for all the crops commonly grown in the survey area.

This soil is well suited to all the commonly grown crops. Floodwaters leave debris, and they can erode deep holes in orchards and in areas occupied by other permanent crops. (Capability unit IIw-3; not placed in a woodland suitability group)

Concord Series

The Concord series consists of poorly drained soils that have formed in alluvium of mixed mineralogy. These soils are on broad valley terraces, in slightly concave depressions and in drainageways. They have slopes of 0 to 2 percent. Elevations range from 125 to 350 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly rushes, sedges, wild blackberry, hazel, annual grasses, and ash trees. Concord soils are associated with Amity and Dayton soils.

In a typical profile, the surface layer is very dark grayish-brown silt loam about 6 inches thick. The subsurface layer is mottled dark-gray silt loam about 9 inches thick. Just below the subsurface layer is a layer of mottled gray and dark-gray silty clay about 4 inches thick. The subsoil is about 10 inches thick. It consists of mottled grayish-brown silty clay in the upper part and of mottled dark grayish-brown silty clay in the lower part. The substratum of mottled dark grayish-brown silt loam extends to a depth of 60 inches or more.

Concord soils that are neither drained nor irrigated are used mainly for cereal grains, pasture, hay, and grass grown for seed. When irrigated, the drained areas are used mainly for berries and vegetables.

Concord silt loam (Co).—This is the only soil of the Concord series mapped in the survey area. It occupies narrow strips along and at the heads of drainageways, and it is also in depressions on terraces. In most places the slope is less than 2 percent.

Representative profile at the eastern edge of the Baldock Freeway, 200 feet north of the overpass (NE¼NE¼ NW¼ sec. 33, T. 5 S., R. 2 W.):

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) when dry; moderate, fine, subangular blocky structure breaking to moderate, fine, granular structure; friable, hard, sticky and plastic; abundant fine roots; many interstitial pores and wormholes; common, fine, brown concretions; medium acid (pH 6.0); abrupt, smooth boundary. (5 to 7 inches thick.)

A21—6 to 9 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) when dry; common, fine, distinct, dark-brown (7.5YR 4/2) mottles; moderate, medium, subangular blocky structure; friable, hard, sticky and plastic; abundant fine roots; many, very fine and few, fine, tubular pores; common, fine, very dark brown concretions; medium acid (pH 5.8); clear, smooth boundary. (1 to 6 inches thick.)

A22—9 to 15 inches, dark-gray (10YR 4/1) heavy silt loam, light gray (10YR 7/1) when dry; common, fine, distinct, dark-brown (7.5YR 4/4) mottles; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; friable, hard, sticky and plastic; few fine roots; many, very fine and common, fine, tubular pores; common, fine, very dark brown concretions; medium acid (pH 6.0); clear, smooth boundary. (4 to 9 inches thick.)

A&B—15 to 19 inches, gray (10YR 5/1) and dark-gray (10YR 4/1) light silty clay, light gray (10YR 7/1 and 10YR 6/1) when dry; darker colors in ped interiors; common, fine, distinct, dark-brown (7.5YR 4/4) mottles; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; friable, hard, sticky and plastic; few fine roots; many, very fine, tubular pores; many, fine, very dark brown concretions; slightly acid (pH 6.2); clear, smooth boundary. (2 to 7 inches thick.)

IIB2t—19 to 24 inches, grayish-brown (2.5Y 5/2) heavy silty clay, light brownish gray (2.5Y 6/2) when dry; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; strong, fine, prismatic structure breaking to strong, medium and fine, angular blocky structure; firm, extremely hard, very sticky and very plastic; very few roots; many, very fine and few, fine and medium, tubular pores; few thin and moderately thick clay films on ped surfaces and in pores; many, fine, very dark brown and few black concretions; slightly acid (pH 6.4); clear, wavy boundary. (4 to 12 inches thick.)

IIB3t—24 to 29 inches, dark grayish-brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) when dry; many, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; massive; firm, very hard, sticky and plastic; few fine roots; common fine pores; common moderately thick clay films along lines of weakness, and few clay films in pores; few, fine, dark-brown and black concretions; neutral (pH 6.6); gradual, smooth boundary. (3 to 9 inches thick.)

IIIC—29 to 60 inches, dark grayish-brown (2.5Y 4/2) silt loam, light gray (2.5Y 7/2) when dry; many, medium, distinct, dark yellowish-brown (10YR 4/4) mottles; friable, hard, sticky and plastic; massive; common, very fine, tubular pores; few black stains; neutral (pH 6.6).

The Ap horizon is dominantly silt loam, but the texture ranges to silty clay loam. In places texture of the IIB2t horizon is clay. Soil reaction ranges from medium acid in the A horizon to slightly acid and neutral in the B and C horizons.

Included with this soil in mapping were small areas of Dayton soils. These included soils make up from 5 to 10 percent of the acreage in the mapping unit.

The available water capacity ranges from 9 to 12 inches. Permeability is slow, and fertility is low. Runoff is slow, and ponding occurs in some areas, especially in depressions. The hazard of erosion is slight. Depth to which roots can penetrate is restricted by the silty clay in the subsoil. It is also restricted by wetness, caused by the poor drainage and by the seasonal high water table. This soil is easily worked, but it tends to compact if it is cultivated when too moist.

Areas of this soil that are neither drained nor irrigated are used for spring small grains, pasture, hay, and grass grown for seed. When irrigated, drained areas are used for berries and vegetables. This soil is well suited to vegetables, small grains, pasture, and hay. (Capability unit IIIw-2; not placed in a woodland suitability group)

Courtney Series

The Courtney series consists of poorly drained soils that have formed in alluvial deposits of different ages. These soils are on gravelly alluvial terraces, where they occur in shallow depressions and in drainageways. Slopes range from 0 to 2 percent, and elevations range from 175 to 650 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly ash, vine maple, hazel, wild rose, blackberry, rushes, sedges, and annual and perennial grasses. Courtney soils are associated with Salem and Clackamas soils.

In a typical profile, the surface layer is about 12 inches thick, and it consists of mottled, black gravelly silty clay loam in the upper part and of mottled, very dark gray gravelly silty clay loam in the lower part. The subsoil is mottled dark-gray gravelly clay about 12 inches thick. The substratum consists of a layer of dark grayish-brown very gravelly clay loam, about 25 inches thick, that grades to mottled, dark-brown very gravelly sand, which extends to a depth of 57 inches or more.

Undrained areas of Courtney soils are used mainly for pasture, hay, and grass grown for seed. The drained areas are used for these crops and also for small grains.

Courtney gravelly silty clay loam (Cu).—This soil is on terraces between Stayton and Salem. It is in depressions and in narrow drainageways. This is the only soil of the Courtney series mapped in the survey area.

Representative profile (NW¼SE¼ sec. 6, T. 8 S., R. 2 W.):

A11—0 to 4 inches, black (10YR 2/1) gravelly silty clay loam, dark gray (10YR. 4/1) when dry; few, fine, distinct, dark-brown (7.5YR 4/4) mottles; strong, medium and fine, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, very fine and fine, interstitial pores; iron stains in root channels; 20 to 25 percent coarse pebbles; strongly acid (pH 5.4); clear, smooth boundary. (2 to 6 inches thick.)

A12—4 to 12 inches, very dark gray (7.5YR 3/0) gravelly silty clay loam, very dark gray (10YR 3/1) when crushed and dark gray (10YR 4/1) when dry; common, medium, distinct, strong-brown (7.5YR 4/4) mottles; strong, medium and fine, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, very fine, tubular pores; iron stains in root channels; 30 percent pebbles; medium acid (pH 5.8); abrupt, smooth boundary. (7 to 10 inches thick.)

IIB2t—12 to 24 inches, dark-gray (10YR 4/1) gravelly clay, gray (10YR 5/1) when dry; few, fine, distinct mottles; weak, coarse, prismatic structure; firm, very hard, very sticky and very plastic; few roots; 30 percent pebbles and a few cobblestones; slightly acid (pH 6.4); clear, smooth boundary, (10 to 20 inches thick.)

IIIC1—24 to 49 inches, dark grayish-brown (10YR 4/2) very gravelly clay loam, gray (10YR 5/1) when dry; massive; firm, hard, sticky and plastic; iron stains; 85 percent pebbles; few cobblestones; slightly acid (pH 6.2); abrupt, smooth boundary. (24 to 48 inches thick.)

IVC2—49 to 57 inches, mottled dark-brown (7.5YR 3/2) very gravelly sand, strong brown (7.5YR 5/6) when moist; massive; friable, soft, nonsticky and nonplastic; many, medium, interstitial pores; neutral (pH 6.7).

Color of the A horizon ranges from black or very dark brown to very dark gray, and texture of that horizon ranges from silty clay loam or clay loam to silty clay. In some places the B horizon is very dark gray, and it is gravelly silty clay in some areas. The amount of gravel in the B horizon ranges from 20 to 30 percent. Depth to the very gravelly C horizon ranges from 24 to 36 inches. The C horizon is stratified. Both the thickness of the different layers in the C horizon and the amount of gravel and cobblestones in that horizon are highly variable.

Included with this soil in mapping were small areas that have a surface layer of very dark gray silt loam.

Above the clay subsoil, the available water capacity is less than 3 inches. Permeability is very slow, and fertility is moderate. Runoff is ponded or very slow, and the hazard of erosion is slight. The depth to which roots can penetrate is restricted by the claypan in the subsoil, but it ranges from 12 to 16 inches. Workability is fair.

Undrained areas of this soil are used for pasture, hay, and grass grown for seed. The drained areas are used for these crops and also for spring small grains and winter wheat. When irrigated, the drained areas are used for sweet corn, berries, and beans. This soil is used for these irrigated crops because it occupies only small areas and extends through and is managed like the adjacent Sifton, Salem, and Clackamas soils. Courtney soils are poorly suited to row crops and root crops. (Capability unit IVw–1; not placed in a woodland suitability group)

Cumley Series

The Cumley series consists of moderately well drained soils that have formed in glacial till and colluvium. These soils are on mountain foot slopes, and they have slopes of 2 to 20 percent. Elevations range from 800 to 2,000 feet. The average annual precipitation is between 55 and 75 inches, the average annual air temperature is 48° to 51° F., and the length of the frost-free season is 165 to 190 days. The vegetation is mainly Douglas-fir, maple, alder, brackenfern, and grasses. Cumley soils are associated with McCully, Kinney, and Minniece soils.

In a typical profile, the surface layer is dark-brown silty clay loam about 9 inches thick. This is covered with a thin layer of decomposing leaves, stems, and twigs. The subsoil is about 37 inches thick and is dark reddish-brown silty clay in the upper part, dark-brown heavy silty clay in the middle part, and mottled brown clay in the lower part. The substratum is mottled, olive-brown clay. Bedrock is at a depth of more than 5 feet.

The Cumley soils are used mainly for timber and for watershed.

Cumley silty clay loam, 2 to 20 percent slopes (ClD).—This is the only soil of the Cumley series mapped in the survey area. It occurs in small areas on foot slopes and within slump areas of McCully soils.

Representative profile 25 feet northwest of a logging road (NE¼NE¼ sec. 25, T. 9 S., R. 2 E.):

O1 and O2—1 inch to 0, layer of duff consisting of partly decomposed leaves, stems, and twigs.

A11—0 to 4 inches, dark-brown (7.5YR 3/2) silty clay loam, dark brown (7.5YR 4/2) when dry; moderate, fine, granular structure; friable, hard, sticky and plastic; many, fine, interstitial pores; many roots; medium acid (pH 6.0); gradual, smooth boundary. (3 to 7 inches thick.)

A12—4 to 9 inches, dark-brown (7.5YR 3/2) silty clay loam, dark brown (7.5YR 4/2) when dry; moderate, fine and medium, subangular blocky structure; friable, hard, sticky and plastic; many, fine and very fine, tubular pores; many roots; slightly acid; clear, smooth boundary. (4 to 8 inches thick.)

B1—9 to 15 inches, dark reddish-brown (5YR 3/4) silty clay, dark brown (7.5YR 4/3) when dry; moderate, medium, subangular blocky structure; firm, very hard, sticky and plastic; common, very fine and fine, tubular pores; many roots; medium acid (pH 5.8); clear, smooth boundary. (4 to 9 inches thick.)

B21t—15 to 25 inches, dark-brown (7.5YR 3/4) heavy silty clay, dark brown (7.5YR 4/4) when dry; moderate, coarse, subangular blocky structure; firm, very hard, very sticky and very plastic; common, very fine and fine, tubular pores; many roots; common thin and moderately thick clay films; common, fine, brown and black concretions; medium acid (pH 5.6). (8 to 14 inches thick.)

B22t—25 to 46 inches, brown (7.5YR 4/4) clay, brown (7.5YR 5/4) when dry; many, coarse, prominent, grayish-brown (2.5Y 5/2) mottles; moderate, coarse, subangular blocky structure; very firm, very hard, very sticky and very plastic; common, very fine and fine, tubular pores; common roots; nearly continuous, thin and moderately thick clay films; few coarse fragments of basalt; strongly acid; clear, smooth boundary. (17 to 25 inches thick.)

C—46 to 60 inches, olive-brown (2.5Y 4/4) clay, grayish brown (2.5Y 5/2) when dry; many, coarse, strong-brown (7.5YR 4/4) mottles; massive; firm, very hard, very sticky and very plastic; few roots; few coarse fragments of basalt; common, very fine and fine, tubular pores; strongly acid.

Texture of the A horizon ranges from silty clay loam to silty clay. In places the A horizon is very dark brown. Mottling in the B22t horizon is distinct in some places. In some areas the entire profile contains a few pebbles, cobblestones, and other stones.

Included with this soil in mapping were small areas of Minniece soils and stony soils.

The available water capacity ranges from 9 to 12 inches. Permeability is moderately slow, and fertility is low. Runoff is medium, and the hazard of erosion is slight. The depth to which roots can penetrate is restricted by wetness and by the layer of clay at a depth of 46 inches.

This soil is used mainly for growing Douglas-fir to which it is moderately well suited. Where cleared, it can be used for small grains, pasture, hay, and grass grown for seed. If this soil is drained and irrigated, it is suitable for some vegetable and berry crops. (Capability unit IIIe–2; woodland suitability group 3c4)

Dayton Series

The Dayton series consists of soils that are poorly drained. These soils have formed mainly in old mixed alluvium, but their upper layers may have been influenced, to some extent, by loess. The soils are on broad valley terraces, and they occur in drainageways and in shallow depressions. Slopes range from 0 to 2 percent, and elevations range from 125 to 350 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly annual and perennial grasses, wild rose, and scattered ash trees. Dayton soils are associated with Amity and Concord soils.

In a typical profile, the surface layer is very dark grayish-brown silt loam about 7 inches thick. The subsurface layer is mottled dark-gray silt loam about 6 inches thick. The subsoil is mottled and consists of a layer of clay about 33 inches thick. It is dark gray in the upper part and is grayish brown in the lower part. The substratum is mottled grayish-brown silty clay loam that extends to a depth of 60 inches or more.

The Dayton soils are used mainly for small grains, pasture, hay, and grass grown for seed.

Dayton silt loam (Da).—This soil is on terraces, where it occupies small areas in drainageways and depressions. It is the only soil of the Dayton series mapped in the survey area.

Representative profile (SW¼NE¼ sec. 16, T. 6 S., R. 2 W.):

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) when dry; few, fine, faint, yellowish-brown (10YR 5/6) mottles; moderate, fine, subangular blocky and granular structure; friable, hard, slightly sticky and slightly plastic; many roots; many, fine, interstitial pores; few, medium, black and red concretions; medium acid (pH 5.6); clear, smooth boundary. (5 to 9 inches thick.)

A2—7 to 13 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 6/1) when dry; common, fine, faint, brownish-yellow (10YR 6/6) mottles; moderate, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; common, very fine, tubular pores; few black and red concretions; medium acid (pH 5.8); abrupt, smooth boundary. (4 to 15 inches thick.)

IIB21t—13 to 25 inches, dark-gray (10YR 4/1) clay, gray (10YR 5/1) when dry; moderate, medium, prismatic structure breaking to coarse and medium, subangular blocky structure; very firm, very hard, very sticky and very plastic; few roots; few, fine, tubular pores; thick, continuous clay films; few black and red concretions; slightly acid (pH 6.4); gradual, smooth boundary. (10 to 24 inches thick.)

IIB22t—25 to 46 inches, grayish-brown (10YR 5/2) clay, light brownish gray (10YR 6/2) when dry; few, fine, faint, yellowish-brown (10YR 5/6) mottles; massive; firm, very hard, very plastic and very sticky; few roots; few, fine, tubular pores; slightly acid (pH 6.4); gradual, smooth boundary.

IIIC—46 to 60 inches, grayish-brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) when dry; common, medium, faint, light olive-brown (2.5Y 5/6) mottles; massive; friable, hard, sticky and plastic; few, fine, tubualr pores; slightly acid (pH 6.2).

Color of the Ap horizon ranges from dark gray to very dark grayish brown when the soil is moist, and from light gray to light brownish gray when the soil is dry. Texture of the Ap horizon ranges from silt loam to silty clay loam.

Included with this soil in mapping were small areas of a Concord soil. The included areas make up as much as 5 percent of the acreage in the mapping unit.

The available water capacity above the clay subsoil is 3 to 6 inches. Permeability is very slow, and fertility is low. Runoff is very slow to ponded, and the hazard of erosion is slight. Roots can penetrate to the claypan, which is at a depth of only 12 to 24 inches. Workability is good, but this soil tends to puddle and compact if it is cultivated when too moist.

Undrained areas of this soil are used for small grains, pasture, hay, and grass grown for seed, and the drained areas are used for corn and for winter and spring small grains. When irrigated, this soil is used for sweet corn and bush beans. Even where it is drained, it is not suited to deep-rooted crops, many perennial crops, and crops that cannot tolerate excessive moisture. (Capability unit IVw-1; not placed in a woodland suitability group)

Hazelair Series

The Hazelair series consists of moderately well drained soils that formed in material weathered from sandstone and shale. These soils have slopes of 2 to 20 percent. They are on foot slopes adjacent to the valley floor, at elevations of 250 to 650 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that have not been cultivated, the vegetation is mainly Oregon white oak, poison-oak, rose, annual weeds and grasses, and a few Douglas-firs. Hazelair soils are associated with Steiwer soils.

In a typical profile, the surface layer is very dark brown silt loam about 12 inches thick. The subsoil is very dark grayish-brown silty clay loam about 6 inches thick. The substratum, about 20 inches thick, is mottled and is dark grayish brown throughout. It is silty clay in the upper part and clay in the lower part. Sandstone bedrock is at a depth of about 38 inches.

The Hazelair soils are used as woodland and for small grains, pasture, hay, and grass grown for seed.

Hazelair silt loam, 2 to 6 percent slopes (HaB).—This soil occupies small areas on the foot slopes of red foothills south of Salem. It also occurs near Scotts Mills.

Representative profile 40 feet south of a gravel road (NE¼NE¼ sec. 25, T. 9 S., R. 3 W.):

Ap—0 to 6 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; weak, medium and fine, granular structure; friable, slightly hard, slightly sticky and slightly plastic; few roots; common, very fine and fine, tubular and interstitial pores; common, fine, rounded concretions or fragments of rock; medium acid (pH 5.8); abrupt, smooth boundary. (6 to 10 inches thick.)

A1—6 to 12 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, medium, subangular blocky structure breaking to strong, very fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; few roots; many, very fine and fine, tubular pores; common gray silt coatings on ped surfaces; medium acid (pH 5.6); clear, smooth boundary. (3 to 6 inches thick.)

B2—12 to 18 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) when dry; weak, medium, prismatic structure breaking to strong, fine and very fine, subangular blocky structure; firm. hard, plastic and sticky; few roots; many, very fine and fine, tubular pores; slightly acid (pH 6.2); clear, smooth boundary. (3 to 10 inches thick.)

IIC1—18 to 28 inches, dark grayish-brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) when dry; few, faint, dark yellowish-brown (10YR 4/4) and few, distinct, light brownish-gray (10YR 6/2) mottles; strong, medium, angular blocky structure; firm, very hard, very sticky and very plastic; few fine roots; common, very fine, tubular pores; many slickensides; many, fine and very fine, black concretions; slightly acid (pH 6.2); gradual, wavy boundary. (5 to 10 inches thick.)

IIC2—28 to 36 inches, dark grayish-brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) when dry; many, medium and fine, distinct, dark yellowish-brown (10YR 4/4) and few, distinct, light brownish-gray (10YR 6/2) mottles; moderate, very coarse and coarse, angular blocky structure; firm, very hard, very sticky and very plastic; no roots; few, very fine, tubular pores; common slickensides; few fine fragments of weathered sandstone; slightly acid (pH 6.4); gradual, wavy boundary. (5 to 8 inches thick.)

IIC3—36 to 38 inches, dark grayish-brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) when dry; many, medium and fine, distinct, yellowish-brown (10YR 4/4) mottles; weak to moderate, coarse, angular blocky structure; firm, very hard, very sticky and very plastic; few, very fine, tubular pores; common slickensides; common, fine, black concretions; many fine and medium fragments of weathered sandstone; slightly acid (pH 6.4); abrupt, slightly wavy boundary. (0 to 4 inches thick.)

IIIR—38 inches, dark yellowish-brown (10YR 4/4), hard, fractured, fine-grained sandstone that is horizontally bedded.

Texture of the A horizon ranges from silt loam to silty clay loam. Mottles that are faint or distinct are within 20 inches of the surface. Depth to the C horizon ranges from 12 to 24 inches.

Included with this soil in mapping were small stony areas, and other areas where bedrock is at a depth of 4 to 5 feet.

The available water capacity is 4 to 7 inches. Permeability is slow, and fertility is low. Runoff is slow, and the hazard of erosion is slight. The depth to which roots and water can penetrate is restricted by the layer of dense clay at some depth below 12 to 24 inches. Workability is fair. If this soil is cultivated when too moist, however, it tends to puddle and a tillage pan forms readily.

This soil is used mainly for small grains, pasture, hay, and grass grown for seed. It is not suitable for fruit trees and deep-rooted crops, unless it is irrigated. When this soil is irrigated, small areas are used for pole beans, sweet corn, strawberries, and caneberries. (Capability unit IIIe-3; not placed in a woodland suitability group)

Hazelair silt loam, 6 to 20 percent slopes (HaD).—This soil has slopes of 6 to 12 percent in as much as 85 percent of the acreage. Runoff is medium, and erosion is a moderate hazard. Small grains, pasture plants, hay, and grass grown for seed are the main crops. (Capability unit IVe-2; not placed in a woodland suitability group)

Hazelair silty clay loam, 2 to 15 percent slopes, eroded (HcD2).—This soil has a profile similar to the one described for Hazelair silt loam, 2 to 6 percent slopes. It has lost as much as three-fourths of the original surface layer through erosion, however, and the present surface layer is very dark grayish-brown, slightly acid silty clay loam. Sheet erosion has caused most of the soil losses, but gully erosion has caused formation of a few shallow gullies. Runoff is medium, and further erosion is a moderate hazard. The available water capacity is only 2 to 3 inches.

Included with this soil in mapping were small areas in which slopes are steeper than 15 percent.

Areas of this Hazelair soil that have not been cleared are used mainly as woodland or for woodland pasture. The small areas that have been cleared are used for improved pasture. Because this soil is droughty, the amount of forage produced is small. (Capability unit VIe-1; not placed in a woodland suitability group)

Henline Series

The Henline series consists of well-drained very stony soils that have formed in colluvium from basalt or agglomerate. These soils have slopes of 6 to 80 percent. They occur on mountainous uplands at elevations of 3,000 to 5,000 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 41° to 45° F., and the length of the frost-free season is 90 to 110 days. The vegetation is mainly noble fir, hemlock, Douglas-fir, and an understory of blue huckleberry, Oregongrape, pathfinder, and beargrass.

In a typical profile, the surface layer is very dark brown very stony sandy loam about 10 inches thick. This is covered with a thin layer of decomposing plant remains. The substratum, just beneath the surface layer, is dark-brown very stony sandy loam. Bedrock of fractured basalt is at a depth of about 30 inches.

The Henline soils are used mainly for producing timber, and for watershed and wildlife habitat.

Henline very stony sandy loam, 6 to 30 percent slopes (HEE).—This soil is on foot slopes of the Cascade Mountains.

Representative profile 100 feet north of a logging road (SE¼NE¼ sec. 21, T. 9 S., R. 4 E.):

O1—½ inch to 0, patchy, partly decomposed plant and animal matter.

A1—0 to 10 inches, very dark brown (10YR 2/2) very stony sandy loam, dark grayish brown (10YR 4/2) when dry; very weak, coarse, subangular blocky structure; very friable, loose, nonsticky and nonplastic; many roots; many very fine pores; 60 to 70 percent coarse fragments; slightly acid (pH 6.4); diffuse, smooth boundary. (5 to 15 inches thick.)

C—10 to 30 inches, dark-brown (10YR 3/3) very stony sandy loam, brown (10YR 5/3) when dry; massive, readily breaking to single grain; very friable, loose, nonsticky and nonplastic; many roots; many interstitial pores; 60 to 70 percent coarse fragments; slightly acid (pH 6.4); clear, wavy boundary. (15 to 30 inches thick.)

IIR—30 inches, fractured basalt.

The content of coarse rock fragments in the soil profile ranges from 50 to 80 percent. In places part of the A horizon has granular structure. Depth to bedrock ranges from 20 to 40 inches.

Included with this soil in mapping were a few rock outcrops and small areas of Whetstone and Kinney soils. These included areas make up as much as 10 percent of the acreage in this mapping unit.

The available water capacity is 3 inches or less. Permeability is moderately rapid, and fertility is low. Runoff is medium, and the hazard of erosion is moderate. Roots can penetrate only to the basalt or agglomerate, at a depth of 20 to 40 inches.

This soil is well suited to forest trees, and it is used mainly for producing timber. It is too stony to be suitable for cultivated crops. (Capability unit VIs-1; woodland suitability group 3o2)

Henline very stony sandy loam, 30 to 55 percent slopes (HEF).—Steep slopes and rapid runoff make this soil highly susceptible to erosion. Rock outcrops are common, and there are a few escarpments.

This soil is used mainly for producing timber. It is more difficult to manage, however, than Henline very stony sandy loam, 6 to 30 percent slopes. Roads are hard to build and are difficult to maintain. (Capability unit VIs-1; woodland suitability group 3r3)

Henline very stony sandy loam, 55 to 80 percent slopes (HEG).—This soil is highly susceptible to erosion because of its very steep slopes and the very rapid runoff. Rock outcrops are numerous, and escarpments are common.

This soil is used mainly for producing timber, but management is extremely difficult. Roads are difficult to build and to maintain. (Capability unit VIIs-1; woodland suitability group 3r4)

Holcomb Series

The Holcomb series consists of somewhat poorly drained soils that are nearly level. These soils have formed mainly in mixed alluvial silts and clays, but they have some loess in the upper layers. They are on terraces. Elevations range from 125 to 350 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly grasses, wild blackberry, rose, and oak. Holcomb soils are associated with Amity and Dayton soils.

In a typical profile, the surface layer is silt loam about 18 inches thick. It is very dark brown in the upper part and is very dark grayish brown in the lower part. The subsurface layer is mottled, dark-brown light silty clay loam about 6 inches thick. The subsoil, about 18 inches thick, is mottled, dark grayish-brown clay in the upper part and is dark grayish-brown silty clay in the lower part.

The Holcomb soils are used mainly for small grains, pasture, hay, and grass grown for seed.

Holcomb silt loam (Ho).—This silty soil occupies small areas adjacent to drainageways on old alluvial terraces. It is the only soil of the Holcomb series mapped in the survey area.

Representative profile (SW¼SW¼SE¼ sec. 4, T. 9 S., R. 2 W.):

Ap—0 to 6 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, coarse, subangular blocky structure breaking to moderate, fine, granular structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many very fine pores; medium acid (pH 5.6); gradual, smooth boundary. (3 to 9 inches thick.)

A1—6 to 18 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, coarse, subangular blocky structure breaking to fine subangular blocky structure; friable, slightly hard, sticky and slightly plastic; many roots; many very fine pores; medium acid (pH 5.8); clear, smooth boundary. (9 to 15 inches thick.)

A2—18 to 24 inches, dark-brown (10YR 3/3) light silty clay loam, light brownish gray (10YR 6/2) when dry; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, fine, subangular blocky structure; firm, hard, sticky and plastic; common roots; common fine pores; common grains of clean silt and sand on ped surfaces; slightly acid (pH 6.2); abrupt, smooth boundary. (2 to 7 inches thick.)

IIB2tg—24 to 34 inches, dark grayish-brown (10YR 4/2) clay, grayish brown (2.5Y 5/2) when dry; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, angular blocky structure breaking to strong, fine, angular blocky structure; very firm, very hard, very sticky and very plastic; few roots; few very fine pores; common thin clay films on ped surfaces; neutral (pH 6.6); clear, smooth boundary. (8 to 12 inches thick.)

IIB3tg—34 to 42 inches, dark grayish-brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) when dry; weak, fine, angular blocky structure; firm, very hard, very sticky and very plastic; no roots; common very fine pores; common thin clay films on ped surfaces; common, medium, black concretions; neutral (pH 6.6).

When the soil is moist, color of the A1 horizon ranges from very dark brown to very dark grayish brown. Depth to the upper part of the B horizon ranges from 20 to 30 inches. In places the lower part of the B horizon is gravelly. In most places a gravelly substratum is within 5 feet of the surface.

Included with this soil in mapping were areas in which the surface layer is dark brown.

Within the root zone, the available water capacity is 4 to 6 inches. Permeability of the subsoil is very slow, and fertility is moderate. Runoff is slow, and erosion is only a slight hazard. Workability is good, but a tillage pan develops if this soil is cultivated when too moist. Roots can penetrate to depths of 20 to 30 inches.

This soil is well suited to small grains, pasture plants, hay, and grass grown for seed, and it is used mainly for those crops. Small areas are drained. When irrigated, these drained areas are used for pole beans, corn, and blackberries. (Capability unit IIIw-1; not placed in a woodland suitability group)

Horeb Series

The Horeb series consists of moderately well drained and well drained soils that have formed in glacial till and colluvium. These soils have slopes of 0 to 35 percent. They occur on terraces and on mountain foot slopes at elevations of 1,600 to 3,500 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 46° to 50° F., and the length of the frost-free season is 120 to 165 days. The vegetation is mainly Douglas-fir, vine maple, brackenfern, swordfern, huckleberry, and sedges. Horeb soils are associated with Kinney soils.

In a typical profile, the surface layer is loam that is very dark brown in the upper part and is very dark grayish brown in the lower part. This is covered with a thin layer of decomposing leaves, needles, and twigs. The subsoil is about 17 inches thick, and it consists of gravelly loam that is dark brown in the upper part and dark yellowish brown in the lower part. The upper part of the substratum is mottled, light olive-brown gravelly loam about 5 inches thick. The lower part of the substratum is mottled, dark grayish-brown cobbly loam that extends to a depth of 60 inches or more.

The Horeb soils are used mainly for growing timber, for watershed, and as habitat for wildlife.

Horeb loam, 2 to 20 percent slopes (HRD).—Some areas of this soil are on foot slopes of the Cascade Mountains. Others occupy old slide or slip areas in these mountains.

Representative profile (NE¼NW¼ sec. 15, T. 9 S., R. 3 E.):

O1—2 inches to 0, organic litter consisting of needles, fern leaves, twigs, and other residue from plants.

A11—0 to 9 inches, very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) when dry; moderate, fine, granular structure; very friable, slightly hard, nonsticky and nonplastic; many, fine and very fine, interstitial pores; many roots; 5 percent fine and medium pebbles; strongly acid (pH 5.2); gradual, wavy boundary. (6 to 12 inches thick.)

A12—9 to 14 inches, very dark grayish-brown (10YR 3/2) loam, brown (10YR 5/3) when dry; moderate, fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many, fine and very fine, interstitial pores; many roots; 10 percent fine and medium pebbles; strongly acid (pH 5.4); clear, wavy boundary. (4 to 7 inches thick.)

B21—14 to 24 inches, dark-brown (10YR 4/3) gravelly loam, light yellowish brown (10YR 6/4) when dry; moderate, fine, subangular blocky structure; friable, hard, slightly sticky and slightly plastic; common roots; common very fine pores; 20 percent pebbles; very strongly acid (pH 4.8); clear, wavy boundary. (8 to 14 inches thick.)

B22—24 to 31 inches, dark yellowish-brown (10YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) when dry; weak, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; few roots; many very fine pores; 25 percent pebbles; very strongly acid (pH 4.8); clear, wavy boundary. (5 to 10 inches thick.)

C1—31 to 36 inches, light olive-brown (2.5Y 5/4) gravelly loam that contains common, medium, distinct, yellowish-brown (10YR 5/6) mottles; pale yellow (2.5Y 8/4) when dry; weak, coarse, subangular blocky structure or massive; friable, slightly hard, slightly sticky and slightly plastic; few roots; common very fine pores; 25 percent pebbles; very strongly acid (pH 4.8); clear, wavy boundary. (4 to 8 inches thick.)

C2—36 to 60 inches, dark grayish-brown (2.5Y 4/2) cobbly loam that contains common, medium, distinct, yellowish-brown (10YR 5/6) mottles; pale yellow (2.5Y 8/4) when dry; massive; firm, hard, sticky and plastic; few roots; many very fine and few medium pores; 15 percent pebbles, and 20 percent cobblestones; very strongly acid (pH 4.8).

Texture of the A horizon ranges to silt loam in some places. Color of the B horizon ranges from dark brown to dark yellowish brown. In some areas as much as 15 percent of the solum consists of fragments coarser than 3 inches in diameter. Thickness of the solum ranges from 24 to 40 inches. Below a depth of 40 inches, the soil material is cobbly loam to very gravelly sand and the content of coarse fragments ranges from 25 to 85 percent.

Included with this soil in mapping were small areas of a steep Kinney soil, and areas that lack a cobbly or gravelly substratum.

The available water capacity is 5 to 7 inches. Permeability is moderate, and fertility is low. Runoff is medium, and the hazard of erosion is slight to moderate. This soil receives extra water that seeps from higher areas. Depth to which roots can penetrate is restricted by wetness caused by seepage and by the cobblestones and gravel in the substratum. Workability is good.

This soil is fairly well suited to use as woodland, and it is especially well suited to Douglas-fir. It is also suited to cultivated crops. (Capability unit IIIe-2; woodland suitability group 1o1)

Horeb gravelly silt loam, gravelly substratum, 0 to 15 percent slopes (HSC).—This is a well-drained soil on terraces. The depth to which roots can penetrate is restricted to about 40 inches by the very gravelly sand in the substratum. Runoff is slow, and the hazard of erosion is slight. Workability is fair.

Included with this soil in mapping were small areas where material from adjacent higher areas has been deposited on the surface of this soil. These included areas have a reddish color.

This Horeb soil is well suited to forest trees. It is used mainly for growing Douglas-fir, but small areas have been cleared and are used for pasture. Small grains, hay, berries, and vegetables could be grown. (Capability unit IIIe-4; woodland suitability group 2c1)

Horeb gravelly silt loam, gravelly substratum, 15 to 35 percent (HSE).—This soil is on abrupt breaks of terrace fronts. Runoff is rapid, and the hazard of erosion is moderate to severe. Included in mapping in some places were a few, small, very gravelly and cobbly areas.

This Horeb soil is used mainly for growing Douglas-fir. It is poorly suited to many of the commonly grown cultivated crops, but it can be used for small grains and pasture. (Capability unit IVe-1; woodland suitability group 2c1)

Hullt Series

The Hullt series consists of well-drained soils that have formed in colluvium derived from sandstone. These soils have slopes of 2 to 60 percent. They occur on the margins of mountainous foot slopes at elevations of 800 to 1,200 feet. The average annual precipitation is 55 to 75 inches, the average annual air temperatiure is 49° to 51° F., and the length of the frost-free season is 165 to 190 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, hemlock, maple, brackenfern, salal, ocean-spray, hazel, snowberry, thimbleberry, strawberry, and trailing blackberry. Hullt soils are associated with Nekia and McCully soils.

In a typical profile, the surface layer is very dark brown clay loam about 9 inches thick. The subsurface layer is variegated dark-brown clay loam about 6 inches thick. The subsoil is about 40 inches thick and is silty clay loam throughout. The upper part of the subsoil consists of a layer that is dark reddish brown and that is underlain by a layer that is reddish brown; the middle part of the subsoil is yellowish red; and the lower part is dark brown. The substratum is variegated strong-brown to yellowish-red, strongly weathered sandstone.

The Hullt soils are used mainly for small grains, pasture, hay, grass grown for seed, trees that grow in wooded areas, and watershed.

Hullt clay loam, 2 to 7 percent slopes (HuB).—This soil is on the lower foot slopes of the Cascade Mountains.

Representative profile (SW¼NE¼ sec. 26, T. 6 S., R. 1 E.):

Ap—0 to 9 inches, very dark brown (7.5YR 2/2) clay loam, dark brown (7.5YR 4/4) when dry; weak, coarse and medium, subangular blocky structure breaking to weak, very fine, subangular blocky structure; friable, hard, sticky and plastic; many roots; many very fine pores; few, very fine, black and reddish-colored concretions; medium acid (pH 5.8); abrupt, wavy boundary. (8 to 10 inches thick.)

A3—9 to 15 inches, variegated dark-brown (7.5YR 3/2 and 3/4) clay loam, brown (7.5YR 4/4) when dry; weak, coarse, prismatic structure breaking to weak, fine and very fine, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, fine and very fine, tubular pores; common worm casts; strongly acid (pH 5.4); clear, smooth boundary. (0 to 8 inches thick.)

B1—15 to 22 inches, dark reddish-brown (5YR 3/4) silty clay loam, reddish brown (5YR 4/4) when dry; weak, coarse and medium, subangular blocky structure; friable, hard, sticky and very plastic; common roots; many, very fine and few, fine, tubular pores; strongly acid (pH 5.4); clear, smooth boundary. (5 to 9 inches thick.)

B21—22 to 33 inches, reddish-brown (5YR 4/4) silty clay loam, reddish brown (5YR 5/4) when dry; weak, medium, subangular blocky structure; friable, hard, sticky and very plastic; common roots; common fine and very fine pores; very strongly acid (pH 5.0); clear, smooth boundary. (9 to 13 inches thick.)

B22—33 to 46 inches, yellowish-red (5YR 4/6) silty clay loam, yellowish red (5YR 5/6) when dry; weak, medium and fine, subangular blocky structure; firm, very hard, sticky and very plastic; few roots; common, fine and very fine, tubular pores; very strongly acid (pH 5.0); gradual, smooth boundary. (10 to 16 inches thick.)

B3—46 to 55 inches, dark-brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 5/6) when dry; common, faint, medium and coarse, reddish-brown (5YR 4/4) mottles; weak, coarse, subangular blocky structure; firm, hard, sticky and very plastic; few roots; common, fine and very fine, tubular pores; few, black, medium stains; very strongly acid (pH 5.0); clear, wavy boundary. (6 to 20 inches thick.)

C—55 inches, variegated strong-brown (7.5YR 5/6 and 5/8), pinkish-gray (7.5YR 6/2), and yellowish-red (5YR 4/6), strongly weathered sandstone; massive; clay films along fractures; very strongly acid (pH 4.8).

Color of the horizon ranges from very dark brown to dark reddish brown. In places the A horizon is silty clay loam. Depth to weathered sandstone ranges from 40 to 60 inches.

Included with this soil in mapping were small eroded areas, where weathered sandstone is less than 30 inches from the surface. These areas make up about 5 percent of the acreage in this mapping unit. Also included were small areas of Nekia and McCully soils that make up from 5 to 10 percent of the acreage in the mapping unit.

The available water capacity is 8 to 10 inches. Permeability is moderately slow, and fertility is low. Runoff is slow, and the hazard of erosion is slight. The depth to which roots can penetrate ranges from 40 to 60 inches. Workability is fair, but it becomes progressively poorer as the content of moisture drops below field capacity.

This soil is well suited to most of the crops commonly grown in the survey area. It is used mainly for small grains, pasture, hay, and grass grown for seed, and it is also used as woodland. In addition, a small acreage is used for pole beans, sweet corn, caneberries, strawberries, and specialty crops. Irrigation is needed if pole beans and sweet corn are to be grown commercially. (Capability unit IIe–3; woodland suitability group 2o1)

Hullt clay loam, 7 to 20 percent slopes (HuD).—In about 60 percent of the acreage, this soil has slopes steeper than 12 percent. Runoff is medium, and erosion is a moderate hazard.

This soil is used for about the same crops as Hullt clay loam, 2 to 7 percent slopes, except that sweet corn is not grown. Tilling of row crops is difficult, and using mechanical methods for harvesting berries and vegetables is not feasible. (Capability unit IIIe–2; woodland suitability group 2o1)

Hullt clay loam, 2 to 20 percent slopes (HTD).—Runoff from this soil is medium, and the hazard of erosion is moderate. Where cleared, this soil is suitable for cultivated crops. It is used mainly as woodland. (Capability unit IIIe–2; woodland suitability group 2o1)

Hullt clay loam, 20 to 30 percent slopes (HTE).—Runoff from this soil is rapid, and the hazard of erosion is severe. This soil is used mainly as woodland and for small grains, pasture, hay, and grass grown for seed. Small areas are also used for strawberries and cherries. Cultivating and harvesting most crops is difficult. (Capability unit IVe–1; woodland suitability group 2o1)

Hullt clay loam, 30 to 60 percent slopes (HTF).—Runoff from this soil is rapid, and the hazard of erosion is severe. This soil is not suitable for cultivated crops. It is used mainly for pasture, as woodland, and for grass grown for seed. (Capability unit VIe–2; woodland suitability group 2c2)

Jory Series

The Jory series consists of well-drained soils that have formed in colluvium from tuffs and basalt. These soils are on low, red foothills that are deeply dissected by drainageways and streams. They have slopes of 2 to 30 percent. Elevations range from 300 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, scattered Oregon oaks, and an understory of poison-oak and rose bushes. Jory soils are associated with Nekia soils.

In a typical profile, the surface layer is dark reddish-brown silty clay loam about 8 inches thick. The subsurface layer is also dark reddish-brown silty clay loam and is about 7 inches thick. The upper part of the subsoil consists of a layer of dark reddish-brown silty clay about 21 inches thick. The lower part of the subsoil is dark reddish-brown clay. Basalt is at a depth of more than 5 feet.

The Jory soils are used for small grains, orchards, pasture, hay crops, and grass grown for seed, and they are also used as woodland, for watershed, for wildlife habitat, and as homesites. Some areas are irrigated and are used for truck crops and vegetables.

Jory silty clay loam, 2 to 7 percent slopes (JoB).—This soil is on low foothills south and east of Salem.

Representative profile west of the Salem bypass (U.S. No. 99) and south of the secondary road running east from Grabenhorst Corners (NW¼NW¼NE¼ sec. 13, T. 8 S., R. 3 W.; profile No. 1 in table 9 in the section "Laboratory Data.") :

Ap1—0 to 4 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) when dry; strong, medium and fine, granular structure; very friable, slightly hard, plastic and sticky; common, soft, fine, spherical pellets (shot); common roots; many, fine and very fine, interstitial pores; medium acid (pH 5.9); clear, smooth boundary. (4 to 8 inches thick.)

Ap2—4 to 8 inches, dark reddish-brown (5YR 3/3) silty clay loam, color the same when dry; weak, fine and very fine, subangular blocky structure; friable, slightly hard, sticky and plastic; few, soft, fine, spherical pellets; common roots; many, fine and very fine, interstitial pores; strongly acid (pH 5.5); clear, smooth boundary. (4 to 12 inches thick.)

A3—8 to 15 inches, dark reddish-brown (5YR 3/3) silty clay loam, color the same when dry; moderate, fine and very fine, subangular blocky structure; friable, slightly hard, very sticky and very plastic; few, soft, fine, spherical pellets; common roots; many, fine and very fine, interstitial and tubular pores; strongly acid (pH 5.5); gradual, smooth boundary. (4 to 7 inches thick.)

B1t—15 to 20 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/3) when dry; moderate, fine, angular blocky structure breaking to strong, very fine, angular blocky structure; friable, hard, very sticky and very plastic; thin, continuous clay films; common roots; many, very fine, tubular pores; strongly acid (pH 5.2); gradual, smooth boundary. (0 to 8 inches thick.)

B21t—20 to 28 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/3) when dry; moderate, medium and fine, angular blocky structure; friable, hard, very sticky and very plastic; thin, continuous clay films; common roots; many, very fine, tubular pores; very strongly acid (pH 5.0); clear, smooth boundary. (6 to 15 inches thick.)

B22t—28 to 36 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/3) when dry; moderate, medium and fine, angular blocky structure; friable, hard, very sticky and very plastic; thin, continuous clay films; few black splotches 1 to 3 millimeters in diameter; few roots; many, very fine, tubular pores; very strongly acid (pH 4.9); clear, smooth boundary. (8 to 20 inches thick.)

B23t—36 to 50 inches, dark reddish-brown (2.5YR 3/4) clay, reddish brown (2.5YR 4/4) when dry; strong, fine and very fine, angular blocky structure; very firm, very hard, plastic and sticky; common black splotches and concretions 3 to 8 millimeters in diameter; thin, continuous clay films; very few roots; many, very fine, tubular pores; very strongly acid (pH 4.9); gradual, smooth boundary. (10 to 20 inches thick.)

B24t—50 to 63 inches, dark reddish-brown (2.5YR 3/4) clay, reddish brown (2.5YR 4/4) when dry; moderate, fine, angular blocky structure; firm, hard, plastic and sticky; few black splotches 3 to 8 millimeters in diameter; thin, continuous clay films; very few roots; many, very fine, tubular pores; very strongly acid (pH 4.9).

Thickness of the A horizon ranges from 12 to 20 inches. Color of the B horizon ranges from dark reddish brown to dark red. The content of clay in the B horizon ranges from about 40 to 60 percent, but the soil material has a coarser feel when rubbed between the fingers. In some places these soils contain a discontinuous stone line at a depth of 2 to 12 feet. In places a few basalt boulders are in all parts of the profile.

Included with this soil in mapping were small areas of a Nekia soil.

The available water capacity is 7 to 10 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and erosion is only a slight hazard. Roots can penetrate to a depth of 5 feet or more. Workability is fair, but it becomes progressively poorer when the content of moisture drops below field capacity.

This soil is used mainly for small grains, orchards (fig. 7), pasture, hay, and grass grown for seed, but a small acreage is used for strawberries, pole beans, sweet corn, caneberries, and specialty crops. When irrigated, this soil is used for most of the crops commonly grown in the survey area. Water for irrigation is obtained from reservoirs and ponds. (Capability unit IIe-3; woodland suitability group 3c1)

Jory silty clay loam, 7 to 12 percent slopes (JoC).—In most places this soil has slopes steeper than 9 percent. Runoff is medium, and the hazard of erosion is moderate. This soil is used for about the same crops as Jory silty clay loam, 2 to 7 percent slopes. (Capability unit IIIe-6; woodland suitability group 3c1)

Jory silty clay loam, 12 to 20 percent slopes (JoD).—Runoff from this soil is medium, and erosion is a moderate hazard. This soil is used for about the same crops as Jory silty clay loam, 2 to 7 percent slopes. Sweet corn is not grown, however, because of the difficulty of using machinery for harvesting the crop. (Capability unit IIIe-2; woodland suitability group 3c1)

Jory silty clay loam, 20 to 30 percent slopes (JoE).—Runoff from this soil is rapid. The hazard of erosion is severe. This soil is used mainly for small grains, pasture, hay, and grass grown for seed, but a small acreage is used for strawberries, for cherries, and as woodland. (Capability unit IVe-1; woodland suitability group 3c1)

Kinney Series

The Kinney series consists of well-drained soils that have formed in glacial till over basic igneous tuffaceous agglomerate. These soils have slopes of 2 to 70 percent. They occur on mountain foot slopes at elevations of 1,000 to 3,500 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is 46° to 50° F., and the length of the frost-free season is 120 to 165 days. The vegetation is mainly Douglas-fir, hemlock, alder, Oregongrape, salal, vine maple, and rhododendron. Kinney soils are associated with Horeb, McCully, and Henline soils.

In a typical profile, the surface layer is very dark brown cobbly loam about 10 inches thick. This is covered by a thin layer of partly decomposed ferns, fir needles, leaves, and twigs, and by a thin layer of well-decomposed, black organic matter. The subsoil is about 30 inches thick. It consists of dark-brown cobbly clay loam in the upper part and of dark yellowish-brown cobbly clay loam in the lower part. The substratum is dark yellowish-brown cobbly loam about 13 inches thick. It is underlain by variegated light olive-brown to dark-red, weathered, basic igneous agglomerate.

The Kinney soils are used mainly for growing timber and for watershed.

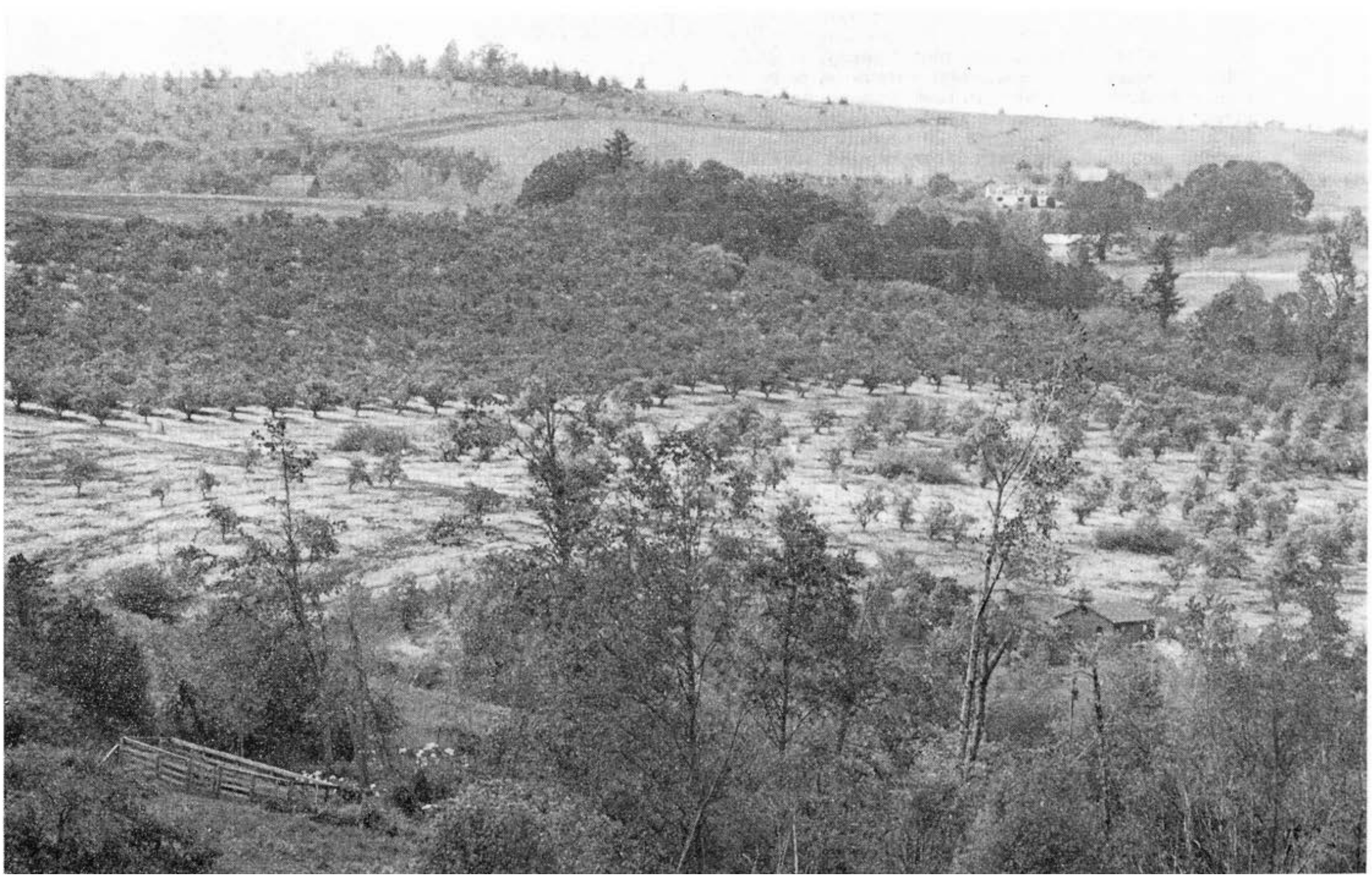

***Figure 7.*—Orchard on Jory silty clay loam, 2 to 7 percent slopes, in the Salem Hills.**

417-910—72——7

Kinney cobbly loam, 2 to 20 percent slopes (KCD).—This soil occupies broad ridges on foot slopes of the Cascade Mountains.

Representative profile about 3 miles southeast of South Burn Guard Station; 60 feet north of South Burn Road (NW¼NE¼SE¼ sec. 31, T. 8 S., R. 2 E.):

O1—2 inches to 1 inch, partly decomposed fern leaves, fir needles, other leaves, and twigs.

O2—1 inch to 0, well-decomposed, black, friable organic matter.

A11—0 to 4 inches, very dark brown (10YR 2/2) cobbly loam, dark brown (10YR 4/3) when dry; moderate, fine, granular structure; friable, slightly hard, slightly sticky and slightly plastic; many fine and medium roots; many, fine, interstitial pores; many medium and fine particles of shot; 25 percent pebbles and angular cobble-size fragments; strongly acid (pH 5.3); clear, smooth boundary. (4 to 6 inches thick.)

A12—4 to 10 inches, very dark brown (10YR 2/2) cobbly loam, dark brown (10YR 4/3) when dry; moderate, medium and fine, granular structure; friable, slightly hard, slightly sticky and slightly plastic; many fine roots; many, fine, interstitial pores; many medium and fine particles of shot; 25 percent pebbles and angular cobble-size fragments; strongly acid (pH 5.1); abrupt, wavy boundary. (4 to 6 inches thick.)

B1—10 to 15 inches, dark-brown (10YR 3/3) cobbly clay loam, dark brown (10YR 4/3) when dry; weak, fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many medium roots; many, very fine, tubular pores; thin, patchy cutans; many medium and fine particles of shot; 30 percent coarse fragments; strongly acid (pH 5.5); clear, wavy boundary. (2 to 6 inches thick.)

B21—15 to 20 inches, dark-brown (7.5YR 3/4) cobbly clay loam, brown (7.5YR 5/4) when dry; weak, medium, subangular blocky structure; friable, slightly hard, sticky and plastic; common roots; many, very fine, tubular pores; thin, continuous cutans on peds, and thin, continuous clay films in root channels and in the larger pores; many, coarse, sand-size particles of material that resembles quartz; 30 percent pebbles and angular cobblestones; very strongly acid (pH 4.6); gradual, smooth boundary. (4 to 20 inches thick.)

B22—20 to 40 inches, dark yellowish-brown (10YR 4/4) cobbly clay loam, yellowish brown (10YR 5/4) when dry; weak, coarse and medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; common roots; many, very fine, tubular pores; moderately thick clay films in some of the larger pores; common, coarse, sand-size particles of material that resembles quartz; 35 percent pebbles and angular, cobble-size fragments of rock; very strongly acid (pH 4.6); clear, wavy boundary. (10 to 25 inches thick.)

C—40 to 53 inches, dark yellowish-brown (10YR 4/4) cobbly loam, light yellowish brown (10YR 6/4) when dry; massive or very weak, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; few roots; many very fine pores; many, coarse, sand-size particles of material that resembles quartz; 35 percent pebbles and angular, cobble-size fragments of rock; very strongly acid (pH 4.8); abrupt, irregular boundary. (0 to 13 inches thick.)

IIR—54 inches, variegated light olive-brown (2.5Y 5/4), pale-yellow (2.5Y 7/4), yellow (2.5Y 7/6), and dark-red (2.5YR 3/6), highly weathered, basic igneous agglomerate; very strongly acid (pH 4.8).

The A horizon is dark brown in some places. The predominant color of the B2 horizon is dark yellowish brown, but the color ranges to strong brown or slightly redder in some areas. Thickness of the solum ranges from 40 to 60 inches, but it is generally between 40 and 48 inches. In places pebbles, cobblestones, and other stones constitute as much as 25 to 50 percent of the solum. The upper part of the profile contains pumice in some areas. Weathered basic igneous agglomerate is at a depth of only 40 to 60 inches in many places, but it is at a much greater depth in some places where the layer of till is many feet thick. Rock crops out in some areas.

Included with this soil in mapping were small areas of McCully and Horeb soils. These included areas make up less than 5 percent of the acreage in the mapping unit.

The available water capacity is 5 to 9 inches. Permeability and fertility are both moderate. Runoff is medium, and erosion is only a slight hazard. Depth to which roots can penetrate ranges from 40 to 60 inches.

This soil is used mainly for growing Douglas-fir to which it is well suited. It is not suited to field crops. (Capability unit VIe–2; woodland suitability group 3o1)

Kinney cobbly loam, 20 to 50 percent slopes (KCF).—This soil contains more rock outcrops than Kinney cobbly loam, 2 to 20 percent slopes. Bedrock commonly crops out along slope breaks between the two soils. Runoff is rapid, and the hazard of erosion is moderate to severe.

This soil is used and is managed about the same as Kinney cobbly loam, 2 to 20 percent slopes. (Capability unit VIe–2; woodland suitability group 3r1)

Kinney cobbly loam, 50 to 70 percent slopes (KCG).—Runoff from this soil is very rapid. The hazard of erosion is very severe.

This soil is used in about the same way as Kinney cobbly loam, 2 to 20 percent slopes. It is not managed, except to harvest the natural stands of timber. Constructing logging roads and performing logging operations are difficult. (Capability unit VIIe–1; woodland suitability group 3r2)

Labish Series

The Labish series consists of poorly drained soils that have formed in mixed mineral and organic material. These soils have slopes of 0 to 1 percent. They occur on the bottoms of former shallow lakes at elevations of 150 to 175 feet. The average annual precipitation is between 40 and 45 inches, the average annual air temperature is 53° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly sedges, tussocks, and willows. Labish soils are associated with Semiahmoo soils.

In a typical profile, the surface layer is black and is about 7 inches thick. It consists of silty clay loam in the upper part and of silty clay in the lower part. The next layer is very dark brown silty clay about 9 inches thick. Below this is very dark gray clay that extends to a depth of 60 inches or more.

The Labish soils are used mainly for onions, small grains, pasture, and hay.

Labish silty clay loam (La).—This is the only soil of the Labish series mapped in the survey area. Nearly all of the acreage is in Lake Labish Bottom and in intermittent drainageways that have their outlets in Lake Labish Bottom.

Representative profile (NE¼SW¼ sec. 14, T. 6 S., R. 2 W.):

Ap1—0 to 3 inches, black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) when dry; strong, fine, granular structure; friable, very hard, sticky and plastic; many roots; many, fine, interstitial pores; slightly acid (pH 6.4); abrupt, smooth boundary. (3 to 6 inches thick.)

Ap2—3 to 7 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) when dry; weak, coarse, subangular blocky structure; firm, very hard, sticky and plastic; common roots; many, fine and medium, tubular pores; medium acid (pH 5.6); abrupt, smooth boundary. (3 to 5 inches thick.)

AC1g—7 to 16 inches, very dark brown (10YR 2/2) silty clay, very dark gray (10YR 3/1) when dry; moderate, coarse, prismatic structure; firm, very hard, very sticky and very plastic; few roots; common, very fine, tubular pores; very strongly acid (pH 4.8); clear, smooth boundary. (7 to 11 inches thick.)

AC2g—16 to 30 inches, very dark gray (N 3/0) clay, very dark gray (N 3/0) when dry; weak, coarse, prismatic structure, massive when wet; very firm, extremely hard, very sticky and very plastic; few very fine pores; common fibrous roots; very strongly acid (pH 4.6); gradual, smooth boundary. (11 to 17 inches thick.)

C1g—30 to 48 inches, very dark gray (N 3/0) clay, very dark gray (N 3/0) when dry; massive; very firm, extremely hard, very sticky and very plastic; few very fine pores; common, medium-sized, light-colored, porous, soft fragments; very strongly acid (pH 4.6); abrupt, smooth boundary. (5 to 25 inches thick.)

C2g—48 to 60 inches, very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) when dry; massive; very firm, extremely hard, very sticky and very plastic; few very fine pores; neutral (pH 7.0).

In most places the content of organic matter in the A horizon is between 10 and 25 percent. The content of organic matter is so high in some places, however, that the A horizon is almost muck. In a few places, thin layers of peat are within 5 feet of the surface.

Included with this soil in mapping were small areas of Wapato and Semiahmoo soils.

The available water capacity is 12 to 15 inches. Permeability is slow, and fertility is high. Workability is only fair. Runoff is very slow to ponded, and erosion is not a hazard or is only a slight hazard. Depth to which roots can penetrate is limited by the high water table. Annual flooding is a hazard to crops.

This soil is used mainly for onions, small grains, pasture, and hay. When irrigated, drained areas are used for vegetables and specialty crops. (Capability unit IIIw–2; not placed in a woodland suitability group)

McAlpin Series

The McAlpin series consists of moderately well drained and somewhat poorly drained soils that have formed in mixed alluvium. These soils are on alluvial fans and alluvial bottoms of small streams and in drainageways that traverse the low foothills. They have slopes of 0 to 6 percent. Elevations range from 250 to 1,000 feet. The average annual precipitation is between 40 and 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, with some ash, rosebush, and grasses. McAlpin soils are associated with Abiqua and Waldo soils.

In a typical profile, the surface layer is dark-brown silty clay loam about 8 inches thick. The subsurface layer is dark reddish-brown silty clay loam about 6 inches thick. The subsoil is dark reddish-brown silty clay loam in the upper part; mottled, dark reddish-brown silty clay in the middle part; and mottled, dark-brown silty clay in the lower part. It extends to a depth of 65 inches or more.

The McAlpin soils are used mainly for small grains, hay, pasture, and grass grown for seed.

McAlpin silty clay loam, 0 to 3 percent slopes (MaA).—This soil is along streams and intermittent drainageways of the Salem, Waldo, and Silverton Hills. The areas are small.

Representative profile 425 feet east and 270 feet north of a road intersection (SE¼NW¼SE¼ sec. 17, T. 9 S., R. 2 W.):

Ap1—0 to 5 inches, dark-brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) when dry; moderate, fine and very fine, granular structure; friable, slightly hard, slightly plastic and slightly sticky; many roots; many interstitial pores, few, medium and fine, reddish-brown concretions; strongly acid (pH 5.5); abrupt, smooth boundary. (4 to 8 inches thick.)

Ap2—5 to 8 inchs, dark-brown (7.5Y 3/2) silty clay loam, brown (7.5YR 4/4) when dry; massive; very firm, hard, slightly plastic and sligthly sticky; common roots; few very fine pores; few, medium and fine, reddish-brown concretions; medium acid (pH 5.6); clear, smooth boundary. (0 to 4 inches thick.)

A3—8 to 14 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) when dry; weak, coarse, prismatic structure breaking to moderate, coarse and fine, granular structure; friable, slightly hard, slightly plastic and slightly sticky; few roots; many, very fine, tubular pores; common, medium and fine, reddish-brown concretions; medium acid (pH 5.7); gradual, smooth boundary. (3 to 9 inches thick.)

B1—14 to 23 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/4) when dry; weak, coarse, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; friable, hard, plastic and sticky; few roots; many, very fine, tubular pores; thin, very dark brown coatings on ped surfaces; common, medium and fine, reddish-brown concretions; medium acid (pH 5.8); gradual, smooth boundary. (6 to 12 inches thick.)

B21—23 to 37 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) when dry; common, fine, faint mottles; weak, coarse, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; firm, hard, plastic and sticky; few roots; many, very fine, tubular pores; thin, very dark brown coatings on ped surfaces and in pores; common, fine and medium, black and reddish-brown concretions; medium acid (pH 5.9); gradual, smooth boundary. (9 to 15 inches thick.)

B22—37 to 51 inches, dark-brown (7.5YR 3/2) silty clay, brown (7.5YR 5/2) when dry; common, medium and fine, faint, brown (10YR 5/3 and 7.5YR 5/2) and gray (10YR 5/1) mottles when moist; moderate, fine, subangular blocky structure; firm, hard, very plastic and very sticky; few roots; many, fine and very fine, tubular pores; thick, dark coatings in root channels and in wormholes; common, fine and medium, black and reddish-brown concretions; medium acid (pH 5.9); clear, smooth boundary. (12 to 16 inches thick.)

B3—51 to 65 inches, dark-brown (7.5YR 4/2) silty clay, brown (7.5YR 5/4) when dry; many, coarse and medium, distinct mottles of light yellowish brown (10YR 6/4), brown (10YR 5/3), and strong brown (7.5YR 5/8) when moist; moderate, fine, subangular blocky structure; firm, hard, very plastic and very sticky; many, very fine and fine, tubular pores; many, fine and medium, black and reddish-brown concretions; medium acid (pH 5.9).

Color of the A horizon ranges from dark brown or very dark brown to dark reddish brown. Color of the B horizon ranges from dark reddish brown. In places the B horizon contains faint mottles below a depth of 20 inches and distinct mottles below a depth of 30 inches. In some areas a few pebbles are scattered throughout the solum.

Included with this soil in mapping were small areas of Abiqua and Waldo soils. These included soils make up less than 5 percent of the acreage in the mapping unit.

The available water capacity is 9 to 11 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and erosion is not a hazard or is only a slight hazard. Depth to which roots can penetrate is restricted by a seasonal high water table. Workability is fair.

When not irrigated, this soil is used for small grains, hay, pasture, and grass grown for seed. When irrigated, it is used for all the crops commonly grown in the survey area, except potatoes and carrots. This soil is well suited to most of the commonly grown crops, but drainage is needed for deep-rooted crops. Outlets for drainage are adequate in most places, and this soil can be readily drained. (Capability unit IIw–1; not placed in a woodland suitability group)

McAlpin silty clay loam, 3 to 6 percent slopes (MaB).—This soil receives runoff from higher areas, and as a result, additional soil material is deposited on its surface. Runoff is medium, and the hazard of erosion is moderate.

About the same kinds of crops are grown on this soil as are grown on McAlpin silty clay loam, 0 to 3 percent slopes. (Capability unit IIe–1; not placed in a woodland suitability group)

McBee Series

The McBee series consists of moderately well drained, undulating soils that formed in mixed alluvium. These soils have slopes of 0 to 3 percent. They occur on flood plains that are traversed by sloughs and old overflow channels. Elevations range from 100 to 650 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, alder, ash, big-leaf maple, oak, and an understory of vine maple, blackberry, shrubs, and grasses. McBee soils are associated with Wapato and Chehalis soils.

In a typical profile, the surface layer is very dark brown silty clay loam about 10 inches thick. The subsoil is about 32 inches thick and is mottled throughout. It is very dark brown silty clay loam in the upper part; dark brown, very dark brown, and very dark grayish-brown silty clay loam in the middle part; and dark grayish-brown clay loam in the lower part. The substratum is mottled, dark-gray clay loam that extends to a depth of 65 inches or more.

McBee soils that are not irrigated are used mainly for small grains, orchards, pasture, hay, and grass grown for seed. They are used mostly for row crops when irrigated.

McBee silty clay loam (Mb).—This is the only soil of the McBee series mapped in the survey area. It occurs along Butte Creek and along the Willamette, Pudding, and Santiam Rivers, and it is subject to frequent overflow.

Representative profile (SE¼SE¼ sec. 6, T. 6 S., R. 1 E.):

Ap—0 to 7 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; moderate, coarse, medium and fine, granular structure; friable, slightly hard, plastic and sticky; many, medium, fine and very fine, interstitial pores; common very fine roots; medium acid (pH 6.0); abrupt, smooth boundary. (6 to 8 inches thick.)

A1—7 to 10 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; few, faint, dark-brown mottles; weak, coarse and medium, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; friable, slightly hard, plastic and sticky; common very fine roots; many, very fine, tubular pores; slightly acid (pH 6.2); clear, smooth boundary. (2 to 5 inches thick.)

B1—10 to 22 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; common, fine, faint mottles of dark brown; moderate, medium, prismatic structure breaking to strong, fine and very fine, subangular blocky structure; friable, slightly hard, plastic and sticky; many, very fine, tubular pores; few roots; many worm casts; slightly acid (pH 6.2); gradual, smooth boundary. (9 to 15 inches thick.)

B2—22 to 35 inches, faintly mottled, dark-brown (10YR 3/3), very dark brown (10YR 2/2), and very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 4/2) and brown (10YR 4/3) when dry; weak, medium, prismatic structure breaking to moderate, coarse and medium, subangular blocky structure; friable, slightly hard, plastic and sticky; many, very fine and few, fine, tubular pores; few very fine roots; slightly acid (pH 6.4); gradual, smooth boundary. (10 to 16 inches thick.)

B3—35 to 42 inches, dark grayish-brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) when dry; many, fine and medium, very dark brown (10YR 2/2), brown (10YR 3/3), and dark yellowish-brown (10YR 4/4) mottles and common, fine, strong-brown mottles; medium and fine, subangular blocky structure; friable, slightly hard, plastic and sticky; very few roots; many, very fine and few, fine, tubular pores; slightly acid (pH 6.4); gradual, smooth boundary. (5 to 11 inches thick.)

Cg—42 to 65 inches, dark-gray (10YR 4/1) clay loam; many, medium and fine, distinct, very dark brown (10YR 2/2) and dark-brown (10YR 3/3) mottles; massive; no roots; many very fine and few fine pores; slightly acid (pH 6.4).

Texture of the A horizon ranges from heavy silt loam to silty clay loam. Depth to mottling ranges from 6 to 24 inches, but mottles are at a depth of 18 inches in many places. Mottles in the A1 and B1 horizons appear to be relic. Coarse fragments are commonly absent to a depth of 40 inches. In some places, however, the content of coarse fragments is as high as 20 percent at depths below 35 inches and it is as high as 50 percent at depths below 40 inches.

Included with this soil in mapping were small areas of a soil that has a layer of gravelly material below a depth of 3 feet. Also included were small areas of Wapato and Chehalis soils.

The available water capacity is 12 to 14 inches or more. In many places the drainage has been improved by lowering the water table and by improving outlets. Depth to which roots can penetrate is still restricted, however, by a seasonal high water table. Permeability and fertility are both moderate, and runoff is slow. Because of the frequent overflow, erosion is a moderate hazard. Workability is good, but regular additions of organic matter are needed to keep the soil structure from deteriorating and to keep tillage from becoming more difficult.

When not irrigated, this soil is used mainly for small grains, orchards, pasture, hay, and grass grown for seed. When irrigated, it is used for caneberries, sweet corn, beans, and hops. Drainage is not necessary for many crops, but it is needed if maximum use is to be made of this soil and if best returns are to be realized. Where this soil is drained, it is suited to all the crops commonly grown in the survey area. (Capability unit IIw–5; not placed in a woodland suitability group)

McCully Series

The McCully series consists of well-drained soils that have formed in till or colluvium underlain by basic igneous tuffaceous agglomerate. These soils have slopes of 2 to

70 percent. They occur on the margins of mountainous foot slopes at elevations of 800 to 2,000 feet. The average annual precipitation is 55 to 75 inches, the average annual air temperature is 48° to 51° F., and the length of the frost-free season is 165 to 190 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, hemlock, vine maple, salal, brackenfern, snowberry, trailing blackberry, and wild strawberry. McCully soils are associated with Jory, Hullt, and Kinney soils.

In a typical profile, the surface layer is dark reddish-brown clay loam about 6 inches thick. This is covered with a thin layer of decomposing fern leaves, fir needles, other leaves, and twigs. The subsurface layer is dark reddish-brown clay loam about 4 inches thick. The subsoil is dark reddish-brown clay about 47 inches thick. A substratum of variegated dark-brown, dark yellowish-brown, and very dark grayish-brown gravelly loam that is mostly weathered agglomerate extends to a depth of 108 inches or more.

The McCully soils are used mainly for timber, watershed, pasture, hay, orchards, small grains, and grass grown for seed. When irrigated, they are used mainly for row crops.

McCully clay loam, 2 to 7 percent slopes (McB).—This soil occurs along the margins of the lower foot slopes of the Cascade Mountains.

Representative profile 0.2 mile southeast of the South Burn guard station, 100 feet east of South Burn Road (SW¼SE¼SW¼ sec. 26, T. 8 S., R. 1 E.) :

O1&O2—1 inch to 0, partly decomposed fern leaves, fir needles, other leaves, and twigs.

A1—0 to 6 inches, dark reddish-brown (5YR 3/2) clay loam, dark brown (7.5YR 4/4) when dry; strong, medium and fine, granular structure; friable to firm, slightly hard, slightly sticky and slightly plastic; many roots; many, fine, interstitial pores; many medium concretions; many, coarse, sand-size fragments of rock; strongly acid (pH 5.4); abrupt, smooth boundary. (6 to 8 inches thick.)

A3—6 to 10 inches, dark reddish-brown (5YR 3/2) clay loam, dark brown (7.5YR 4/4) when dry; strong, medium and fine, granular structure; friable, slightly hard, sticky and plastic; many roots; many, fine, interstitial pores; few thin cutans; common, medium, reddish concretions; common, coarse, sand-size, light-colored fragments of rock; strongly acid (pH 5.2); clear, wavy boundary. (4 to 6 inches thick.)

B21—10 to 24 inches, dark reddish-brown (5YR 3/4) clay, yellowish red (5YR 4/6) when dry; weak, medium, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, very fine, tubular pores; few thin cutans; few small concretions; few, coarse, sand-size fragments of light-colored rock; very strongly acid (pH 4.6); clear, smooth boundary. (9 to 15 inches thick.)

B22—24 to 49 inches, dark reddish-brown (5YR 3/4) clay, yellowish red (5YR 4/6) when dry; weak, coarse and medium, subangular blocky structure; firm, hard, sticky and plastic; common roots; many, very fine, tubular pores; continuous, thin cutans; few concretions; very strongly acid (pH 4.6); gradual, smooth boundary. (14 to 30 inches thick.)

B3—49 to 57 inches, dark reddish-brown (5YR 3/4) clay, reddish brown (5YR 4/4) when dry; weak, medium and fine, subangular blocky structure; friable, hard, sticky and plastic; few roots; many, very fine, tubular pores; few thin cutans; few small concretions; very strongly acid (pH 4.6); clear, wavy boundary. (7 to 10 inches thick.)

IIC—57 to 108 inches, variegated dark-brown (10YR 4/3), dark yellowish-brown (10YR 4/4), dark-brown (7.5YR 4/4), and very dark grayish-brown (2.5Y 3/2) gravelly loam that is mostly weathered rock; massive; very strongly acid (pH 4.6); many feet thick.

In some places the A horizon is stony. Rock outcrops are absent from some areas and are common in others. In places a few large boulders are on the surface and angular fragments of rock the size of cobblestones make up from 5 to 15 percent of the A and B horizons. The solum is predominantly dark reddish brown, but the color ranges from dark brown in the A horizon to dark red in the B horizon. In places the B2 horizon is silty clay. The solum ranges from 40 to 60 inches in thickness, but it is commonly 40 to 48 inches thick. Depth to weathered agglomerate ranges from 40 inches to 12 feet. The entire profile is strongly acid or very strongly acid.

Included with this soil in mapping were small areas of Kinney and Cumley soils.

The available water capacity is 8 to 10 inches. Permeability is moderately slow, and fertility is low. Runoff is slow, and the hazard of erosion is slight. The depth to which roots can penetrate is 40 to 60 inches or more. Workability is fair, but it becomes progressively poorer as the content of moisture decreases to below field capacity.

This soil is well suited to pasture plants, hay, orchards, small grains, and grass grown for seed, and it is used mainly for those crops. Much of the acreage has been cleared and is used extensively for crops that require cultivation. A small acreage is used for strawberries, and other small acreages are used for pole beans, sweet corn, berries, and specialty crops. A limited supply of water for irrigation is available from reservoirs and ponds. (Capability unit IIe–3; woodland suitability group 2o1)

McCully clay loam, 7 to 12 percent slopes (McC).—This soil has slopes of more than 9 percent in most places. Runoff is medium, and the hazard of erosion is moderate. Bedrock crops out in a few places.

This soil is used for about the same crops as McCully clay loam, 2 to 7 percent slopes. More careful management is needed, however, to control erosion. (Capability unit IIIe–6; woodland suitability group 2o1)

McCully clay loam, 12 to 20 percent slopes (McD).—This soil contains a few stony areas. Runoff is medium, and erosion is a moderate hazard.

In general, this soil is used for about the same crops as McCully clay loam, 2 to 7 percent slopes. Sweet corn is not grown, however, because of the difficulty of harvesting the crop. Tilling and irrigating row crops so that soil losses will not be excessive is difficult. Mechanical harvesting of vegetables and berry crops is not feasible. (Capability unit IIIe–2; woodland suitability group 2o1)

McCully clay loam, 20 to 30 percent slopes (McE).—In a few places, this soil contains rock outcrops. Runoff is rapid, and the hazard of erosion is severe.

This soil is used mainly as woodland and for small grains, pasture, hay, and grass grown for seed. A small acreage is used for strawberries and cherries. Crops are difficult to cultivate and harvest. For row crops, practices that help to prevent excessive soil losses are necessary, but those practices are difficult to apply without damaging the crop. (Capability unit IVe–1; woodland suitability group 2o1)

McCully clay loam, 2 to 30 percent slopes (MUE).—In a few places, bedrock crops out in areas of this soil. Runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly for growing Douglas-fir. Where cleared, it is suitable for cultivated crops. Logging is best done in summer, when this soil is drier than at other times. (Capability unit IVe–1; woodland suitability group 2o1)

McCully clay loam, 30 to 50 percent slopes (MUF).—In this soil, bedrock crops out in a few places. Runoff is rapid. The hazard of erosion is severe.

This soil is not suitable for crops that require cultivation, and nearly all of the acreage is in Douglas-fir. Small areas are used for improved pasture and for grass grown for seed, although this soil is poorly suited to these uses. (Capability unit VIe–2; woodland suitability group 2c2)

McCully clay loam, 50 to 70 percent slopes (MUG).—Runoff from this soil is very rapid, and the hazard of erosion is very severe. In places small areas that have a stony surface layer were included in mapping.

This McCully soil is used mainly for growing Douglas-fir. Except for harvesting the timber, management is not feasible. Logging is best done in summer, when this soil is drier than at other times. (Capability unit VIIe–1; woodland suitability group 2c3)

McCully stony clay loam, 2 to 20 percent slopes (MID).—Angular pebbles, one-half inch to 3 inches in diameter, make up from 20 to 30 percent, by volume, of the surface layer of this soil. Rock outcrops are common, and small areas of this soil are shallow over bedrock. Runoff is medium, and erosion is a moderate hazard. The available water capacity is moderate.

This soil is used mainly for pasture and for grass grown for seed, but some areas are used for cultivated crops. Tillage is more difficult than for less sloping, less stony McCully soils. In areas to be tilled, the larger stones are usually removed by hand. (Capability unit IIIe–4; woodland suitability group 2o1)

McCully very stony clay loam, 2 to 30 percent slopes (MmE).—From 45 to 55 percent of this soil, by volume, consists of angular fragments of rock. The fragments range from 1 to 9 inches in diameter. Rock outcrops are common. The available water capacity is low.

Because of the stones in the surface layer, this soil is not suitable for crops that require cultivation, and it is used mainly for growing Douglas-fir. Logging is best done in summer, when the soil is drier than at other times. (Capability unit VIs–1; woodland suitability group 3c2)

Minniece Series

The Minniece series consists of deep, somewhat poorly drained and poorly drained soils that have formed in colluvium and alluvium from basic igneous tuffs or agglomerate. These soils have slopes of 0 to 8 percent. They occur in seepage areas and in drainage channels at elevations ranging from 800 to 3,000 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is 47° to 50° F., and the length of the frost-free season is 145 to 190 days. The vegetation is mainly alder, maple, swordfern, skunkcabbage, and sedges. Minniece soils are associated with McCully, Horeb, and Kinney soils.

In a typical profile, the surface layer is very dark grayish-brown silty clay loam about 10 inches thick. The subsoil is mottled throughout and is about 22 inches thick. It is dark grayish-brown silty clay loam in the upper part, dark grayish-brown silty clay in the middle part, and gray clay in the lower part. The substratum is gray clay that extends to a depth of 60 inches or more. The substratum, like the subsoil, is mottled.

The Minniece soils are used mainly for producing timber and for watershed.

Minniece silty clay loam, 0 to 8 percent slopes (MYB).—This soil occupies small seep areas and small areas in drainageways on the lower slopes of the Cascade Mountains. It is the only soil of the Minniece series mapped in the survey area.

Representative profile 50 feet west of logging road (SW¼NE¼ sec. 22, T. 9 S., R. 3 E.):

A1—0 to 5 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) when dry; moderate, fine, granular structure; friable, hard, slightly sticky and plastic; many roots; many, fine, interstitial pores; medium acid (pH 5.8); clear, smooth boundary. (3 to 7 inches thick.)

A3—5 to 10 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) when dry; moderate, medium, subangular blocky structure; firm, hard, sticky and plastic; many roots; common, very fine and few, medium, tubular pores; medium acid (pH 5.8); clear, smooth boundary. (3 to 7 inches thick.)

B1—10 to 15 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) when dry; common, distinct, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; firm, hard, sticky and plastic; common roots; common, very fine, tubular pores; few thin clay films; medium acid (pH 5.8); clear, smooth boundary. (3 to 7 inches thick.)

IIB21tg—15 to 19 inches, dark grayish-brown (10YR 4/2) silty clay, light gray (10YR 7/2) when dry; many, medium, distinct, strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure breaking to strong, medium, subangular blocky structure; firm, very hard, sticky and plastic; common roots; common, very fine and few, fine, tubular pores; few thin clay films; ped surfaces coated with white (10YR 8/1) particles of silt; medium acid (pH 5.8); clear, smooth boundary. (2 to 6 inches thick.)

IIB22tg—19 to 32 inches, gray (10YR 5/1) clay, light gray (10YR 6/1) when dry; many, medium, distinct, strong-brown (7.5YR 5/6) mottles; moderate, coarse, prismatic structure breaking to weak, medium, subangular blocky structure; very firm, extremely hard, very sticky and very plastic; few roots; few, very fine and fine, tubular pores; common thin clay films; medium acid (pH 5.8); clear, smooth boundary. (11 to 16 inches thick.)

IICg—32 to 60 inches, gray (10YR 5/1) clay, light gray (10YR 6/1) when dry; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; massive; very firm, extremely hard, very sticky and very plastic; few roots; few, very fine, tubular pores; medium acid (pH 5.8); few black stains.

Color of the A horizon ranges from very dark brown to very dark grayish brown. Color of the B horizon ranges from dark grayish brown to gray. In some places the entire solum contains mottles. A few stones are scattered throughout the solum in some areas.

Included with this soil in mapping were small stony areas.

The available water capacity ranges from 6 to 8 inches. Permeability is very slow, and fertility is low. Runoff is slow to medium, and the hazard of erosion is slight. Depth to which roots can penetrate varies because of differences in the height of the water table, but the root depth is generally shallow. This soil receives additional water as the result of seepage from higher areas. Therefore, it is wet during most of the year.

This soil is used mainly for growing alder and maple to which it is moderately well suited. Small areas have been cleared and are used for pasture. The difficulties of building roads and of conducting logging operations are limitations to use of this soil for producing timber. Because the areas are small, however, roads can generally be built around them. Drainage is needed in areas used for pasture, and response is generally good where drainage has been established. Under the present management, draining areas of this soil to be used for timber is not economically feasible. (Capability unit VIw–1; not placed in a woodland suitability group)

Nekia Series

The Nekia series consists of well-drained soils that have formed in material weathered from tuffs and basalt. These soils are on low, red foothills that are dissected by drainage channels and streams. They have slopes of 2 to 50 percent. Elevations range from 300 to 1,000 feet. The normal annual precipitation is 40 to 60 inches, the normal annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, but it includes a few scattered oaks and an understory of poison-oak, rose, and brackenfern. Nekia soils are associated with Jory soils.

In a typical profile, the surface layer is dark reddish-brown silty clay loam about 9 inches thick. The subsoil is dark reddish-brown clay about 27 inches thick. Basalt bedrock underlies the subsoil at a depth of about 36 inches.

The Nekia soils are used mainly as woodland and for small grains, orchards, pasture, hay, and grass grown for seed. Some areas are irrigated.

Nekia silty clay loam, 2 to 7 percent slopes (NeB).—This soil is in the Salem, Waldo, and Silverton Hills.

Representative profile 150 feet south of a paved road (NW¼SW¼NW¼ sec. 17, T. 8 S., R. 1 W.):

Ap—0 to 9 inches, dark reddish-brown (5YR 2/2) silty clay loam, reddish brown (5YR 4/3) when dry; moderate, medium and fine, granular structure; friable, slightly hard, plastic and sticky; many roots; many, fine, interstitial pores; medium acid (pH 5.6); abrupt, wavy boundary. (5 to 10 inches thick.)

B1—9 to 18 inches, dark reddish-brown (5YR 3/3) clay, reddish brown (5YR 4/4) when dry; weak, medium, prismatic structure breaking to weak, very fine, granular structure; friable, slightly hard, plastic and sticky; common roots; many, very fine, tubular pores; strongly acid (pH 5.5); clear, smooth boundary. (3 to 12 inches thick.)

B21t—18 to 24 inches, dark reddish-brown (5YR 3/3) clay, reddish brown (5YR 4/4) when dry; weak, very coarse, prismatic structure breaking to moderate, fine and very fine, subangular blocky structure; friable, hard, plastic and sticky; common roots; many, very fine, tubular pores; few thin clay films on ped surfaces and in pores; strongly acid (pH 5.4); clear, smooth boundary. (4 to 18 inches thick.)

B22t—24 to 36 inches, dark reddish-brown (5YR 3/4) clay, yellowish red (5YR 4/6) when dry; very weak, coarse, prismatic structure breaking to moderate, fine and very fine, subangular blocky structure; firm, hard, very plastic and very sticky; few roots; many, very fine, tubular pores; many moderately thick clay films on ped surfaces and in pores; very few, faint, black coatings on ped surfaces; very few, fine, black concretions; many, coarse, sand-size fragments; strongly acid (pH 5.3); clear, wavy boundary. (8 to 18 inches thick.)

R1—36 to 45 inches, fractured bedrock, the fractures filled with reddish-brown (5YR 4/4) clay, reddish brown (5YR 5/3) when dry; weak, fine and very fine, subangular blocky structure; firm, hard, very plastic and very sticky; few large roots; many, very fine, tubular pores; few thick clay films on stone surfaces and in pores; variegations in color caused by weathering of the fragments of rock; many, medium, black coatings on stone surfaces; few, medium, black concretions; 90 percent of horizon is fractured, hard rock; strongly acid (pH 5.3); clear, wavy boundary.

R2—45 inches, basalt bedrock.

Color of the A horizon ranges from dark brown to dark reddish brown. Color of the B2 horizon ranges from dark reddish brown to yellowish red, but it is dominantly dark reddish brown. In places the B2 horizon is silty clay. The content of coarse fragments of hard basalt in the A horizon ranges from 0 to 15 percent, but the content of coarse fragments in the B22t horizon is as high as 50 percent. Depth to bedrock ranges from 20 to 40 inches. Bedrock is at a depth of more than 30 inches in most places.

Included with this soil in mapping were small areas of Jory and McCully soils. These included soils make up from 10 to 15 percent of the acreage in the mapping unit.

The available water capacity is 4 to 7 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and erosion is only a slight hazard. The depth to which roots can penetrate ranges from 20 to 40 inches, but it is more than 30 inches in most places. Workability is only fair, and it becomes progressively poorer as the content of moisture drops below field capacity.

This Nekia soil is well suited to the commonly grown crops. Nonirrigated areas are used mainly for small grains, orchards, pasture, hay, and grass grown for seed, but small acreages are used for strawberries, field corn, caneberries, and specialty crops. When irrigated, this soil is used for pole beans and sweet corn (fig. 8). Irrigation water is obtained from reservoirs and ponds. (Capability unit IIe–3; woodland suitability group 3c1)

Nekia silty clay loam, 7 to 12 percent slopes (NeC).—This soil has slopes that are mainly steeper than 9 percent. Bedrock crops out in a few places. Runoff is medium, and erosion is a moderate hazard.

Included with this soil in mapping were areas of Jory, McCully, and Witzel soils. These included soils make up from 5 to 10 percent of the acreage in this mapping unit.

This Nekia soil is used for about the same crops as Nekia silty clay loam, 2 to 7 percent slopes, but irrigation and tillage of row crops are more difficult. Mechanical harvesting of vegetables and berries is not feasible. (Capability unit IIIe–6; woodland suitability group 3c1)

Nekia silty clay loam, 12 to 20 percent slopes (NeD).—This soil contains a few stony areas and areas of rock outcrop. Runoff is medium. The hazard of erosion is moderate.

Included with this soil in mapping were areas of Jory, McCully, and Witzel soils. These included soils make up from 5 to 10 percent of the acreage in this mapping unit.

This Nekia soil is used for about the same crops as Nekia silty clay loam, 2 to 7 percent slopes, except that sweet corn is not grown. Row crops are grown on a small acreage, but it is difficult to till and irrigate them. Mechanical harvesting of vegetables and berries is not feasible. (Capability unit IIIe–2; woodland suitability group 3c1)

Nekia silty clay loam, 20 to 30 percent slopes (NeE).—On steep breaks a few small areas of this soil are stony and rock crops out in places. Runoff is rapid, and the hazard of erosion is severe.

Included with this soil in mapping were areas of Witzel soils. These included areas make up about 5 percent of the acreage in the mapping unit.

This Nekia soil is used mainly for small grains, pasture, hay, and grass grown for seed, but a small acreage is used for strawberries, for cherries, or as woodland. The crops

Figure 8.—**Irrigated sweet corn on Nekia silty clay loam, 2 to 7 percent slopes, near Stayton.**

are difficult to cultivate and to harvest. If row crops are grown, practices required to prevent excessive soil losses are difficult to apply without damaging the crop. (Capability unit IVe–1; woodland suitability group 3c1)

Nekia silty clay loam, 30 to 50 percent slopes (NeF).—In a few places, this soil contains small stony areas that lie below the few areas of rock outcrop. Runoff is rapid or very rapid, and the hazard of erosion is severe.

Included with this soil in mapping were areas of Witzel soils. These included areas make up less than 5 percent of the acreage in the mapping unit.

This Nekia soil is used mainly for pasture or as woodland. (Capability unit VIe–2; woodland suitability group 3c3)

Nekia stony silty clay loam, 2 to 12 percent slopes (NkC).—This soil has a profile similar to the one described for Nekia silty clay loam, 2 to 7 percent slopes, except that the surface layer is stony and bedrock crops out in a few places. The stones hinder tillage and make this soil slightly droughty. The available water capacity is 2½ to 7 inches. Runoff is medium, and erosion is a moderate hazard.

Included with this soil in mapping were areas of Witzel soils. These included areas make up from 5 to 10 percent of the acreage in this mapping unit.

This Nekia soil is used for about the same crops as Nekia silty clay loam, 2 to 7 percent slopes, but irrigation and tillage of row crops are more difficult. Mechanical harvesting of vegetables and berries is feasible where the slopes are less than 5 percent. (Capability unit IIIe–4; woodland suitability group 3c1)

Nekia very stony silty clay loam, 2 to 30 percent slopes (NsE).—This soil has a profile similar to the one described for Nekia silty clay loam, 2 to 7 percent slopes, except that the surface layer is very stony and rock outcrops are common. The available water capacity is 2½ to 5½ inches. Runoff is medium, and the hazard of erosion is slight to moderate.

Included with this soil in mapping were areas of Witzel soils. These included areas make up from 10 to 15 percent of the acreage in this mapping unit.

This Nekia soil is not suited to cultivated crops, and it is used mainly for woodland-grass pasture and as woodland. The wooded areas are within or adjacent to fields where grass is grown for seed. When these fields are burned over each year, extreme care is necessary to protect the wooded areas from fire. (Capability unit VIs–1; woodland suitability group 3c2)

Nekia very stony silty clay loam, 30 to 50 percent slopes (NsF).—This soil has a profile similar to the one described for Nekia silty clay loam, 2 to 7 percent slopes, except that the surface layer is very stony and rock outcrops are common. Runoff is rapid, and the hazard of erosion is severe.

Included with this soil in mapping were areas of Witzel soils. These included areas make up from 5 to 10 percent of the acreage in this mapping unit.

This Nekia soil is not suited to cultivated crops, and it is used mainly as woodland and for woodland-grass pasture. The wooded areas are within or adjacent to fields where grass is grown for seed. When these fields are burned over each year, extreme care is necessary to protect the wooded areas from fire. (Capability unit VIs-1; woodland suitability group 3c3)

Newberg Series

The Newberg series consists of somewhat excessively drained soils that have formed in mixed alluvium over sandy or gravelly material. These soils are on flood plains that are traversed by old, meandering overflow channels and sloughs, and they are subject to frequent overflow. Slopes range from 0 to 3 percent, and elevations range from 100 to 650 feet. The average annual precipitation is between 40 and 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly ash, oak, Douglas-fir, willow, rose, blackberry, annual grasses, and weeds. Newberg soils are associated with Cloquato, Chehalis, and Camas soils.

In a typical profile, the surface layer is very dark grayish-brown fine sandy loam about 10 inches thick. The substratum, just beneath the surface layer, is dark yellowish-brown sandy loam that extends to a depth of 60 inches or more.

The Newberg soils are used mainly for small grains, orchards, pasture, row crops, and grass grown for seed.

Newberg fine sandy loam (Nu).—This soil is along the channels of Butte Creek and the Willamette, Pudding, and Santiam Rivers.

Representative profile (NE¼SE¼ sec. 24, T. 9 S., R. 2 W.):

Ap—0 to 10 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) when dry; weak, medium and fine, subangular blocky structure; very friable, soft, nonsticky and nonplastic; many, fine and very fine, tubular pores; many roots; medium acid (pH 6.0); clear, smooth boundary. (7 to 12 inches thick.)

C—10 to 60 inches, dark yellowish-brown (10YR 3/4) sandy loam, grayish brown (10YR 5/2) when dry; massive; very friable, soft, nonsticky and nonplastic; many roots; many, fine, interstitial pores; neutral (pH 6.6).

Texture of the A horizon ranges from fine sandy loam to silt loam. When the soil is moist, the color of the A horizon is as dark or darker than dark brown. Color of the C horizon ranges from dark grayish brown to dark yellowish brown. In some places the C horizon is structureless, and in others it has weak, subangular blocky structure. Depth to sand and gravel is more than 40 inches. In some areas as much as 15 percent of the material between depths of 10 and 40 inches is coarse fragments.

Included with this soil in mapping were small areas that have a few pebbles in the surface layer and that have a gravelly subsoil. Also included were small areas of Camas, Cloquato, and Chehalis soils.

The available water capacity is 5 to 7 inches. Permeability is moderately rapid, and fertility is moderate. Roots can penetrate to a depth of 5 feet or more. Runoff is slow, and the hazard of erosion is moderate. Even where management is poor, workability of this soil is excellent, for the texture and structure of the soil material are difficult to change.

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This soil is well suited to small grains, orchards, pasture, and grass grown for seed, and it is used mainly for those crops. When irrigated, it is used for all the crops commonly grown in the survey area. (Capability unit IIw-4; not placed in a woodland suitability group)

Newberg silt loam (Nw).—This soil has a profile similar to the one described for Newberg fine sandy loam, except that the surface layer is finer textured and is dark brown. Because of this finer texture of the surface layer, the range of moisture content within which this soil can be satisfactorily worked is narrower than for Newberg fine sandy loam. Also, the infiltration rate is reduced, and movement of water is slower through the surface layer to the coarser textured material below. The available water capacity is 6 to 7 inches.

This soil is used for about the same crops as Newberg fine sandy loam, except that it is not used for crops that are harvested late in fall. Irrigation is difficult because areas of this soil are small and are within larger areas of Cloquato and Chehalis soils. (Capability unit IIw-6; not placed in a woodland suitability group)

Salem Series

The Salem series consists of well-drained soils that are nearly level. These soils have formed in gravelly alluvium that is of mixed mineralogy and contains a large amount of basaltic pebbles. They occur on terraces at elevations of 100 to 600 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, oak, maple, wild rose, and grasses. Salem soils are associated with Sifton and Clackamas soils.

In a typical profile, the surface layer is very dark brown gravelly silt loam about 9 inches thick. The subsoil is about 21 inches thick and is very dark brown gravelly silty clay loam in the upper part and is dark-brown gravelly clay loam in the lower part. The substratum is grayish-brown very gravelly sand that extends to a depth of 60 inches or more.

The Salem soils are used mainly for small grains, pasture, vegetables, orchards, and berries.

Salem gravelly silt loam (Sa).—This is the only soil of the Salem series mapped in the survey area. It is along the margins of gravelly terraces, adjacent to the alluvial bottoms of the North Santiam and Santiam Rivers.

Representative profile 100 feet south of the Marion to West Stayton highway (SE¼NW¼SW¼ sec. 14, T. 9 S., R. 2 W.):

Ap—0 to 9 inches, very dark brown (10YR 2/2) gravelly silty loam, dark grayish brown (10 YR 4/2) when dry; cloddy and has weak, medium and fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many, very fine, tubular pores; 15 percent pebbles; slightly acid (pH 6.2); gradual, smooth boundary. (6 to 12 inches thick.)

B2t—9 to 18 inches, very dark brown (10YR 2/2) gravelly silty clay loam, brown (10YR 4/3) when dry; moderate, medium, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, fine and very fine, tubular pores; 15 percent pebbles; few thin and moderately thick clay films; slightly acid (pH 6.4); abrupt, smooth boundary. (8 to 20 inches thick.)

B3t—18 to 30 inches, dark-brown (10YR 3/3) gravelly clay loam; brown (10YR 5/3) when dry; massive; firm, hard, slightly sticky and plastic; common roots; common, fine and very fine, tubular pores; thin clay coatings on sand grains; 45 percent pebbles; neutral (pH 6.6); clear, smooth boundary. (0 to 14 inches thick.)

IIC—30 to 60 inches, grayish-brown (10YR 5/2) very gravelly sand, pale brown (10YR 6/3) when dry; single grain; very friable, loose, nonsticky and nonplastic; few roots; many, medium, interstitial pores; 60 percent pebbles; slightly acid (pH 6.2); many feet thick.

Texture of the A horizon ranges from gravelly silt loam to gravelly loam. Texture of the B horizon ranges from gravelly clay loam to gravelly silty clay loam. The content of pebbles and cobblestones in the A and B horizons ranges from 10 to 50 percent, but it is less than 35 percent in most places. In the C horizon, the content of coarse fragments, mostly pebbles, ranges from 35 to 80 percent. Depth to the very gravelly sand of the C horizon ranges from 20 to 40 inches.

Included with this soil in mapping were small areas in which the content of pebbles in the surface layer is less than 15 percent. Also included were areas of a soil that is shallow over very gravelly sand and has a surface layer of dark-brown loam.

The available water capacity is 5 to 6 inches. Permeability and fertility are both moderate. Runoff is slow, and erosion is not a hazard. Depth to which roots can penetrate is restricted by the gravelly substratum. Workability is generally good, but some small areas that have a gravelly surface layer are hard to cultivate.

This soil is used mainly for cereal grains, pasture, caneberries, strawberries, vegetables, and orchards. Irrigation is necessary if vegetables and berries are to be grown commercially. (Capability unit IIs-1; not placed in a woodland suitability group)

Salkum Series

The Salkum series consists of well-drained soils that have formed in weathered gravelly alluvium. These soils have slopes of 0 to 20 percent. They occur on remnants of old, high terraces at elevations of 300 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 200 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, poison-oak, and rose. Salkum soils are associated with Nekia and Jory soils.

In a typical profile, the surface layer is very dark brown silty clay loam about 14 inches thick. The subsoil is dark brown and is about 26 inches thick. The upper part of the subsoil is silty clay loam, and the lower part is mottled silty clay. The upper part of the substratum is variegated light-gray, yellowish-red, brown, and strong-brown silty clay loam to a depth of about 48 inches. The lower part of the substratum is mottled, variegated strong-brown and dark-brown gravelly and cobbly clay loam or silty clay loam that extends to a depth of 65 inches or more.

The Salkum soils are used mainly for small grains, orchards, pasture, hay, and grass grown for seed.

Salkum silty clay loam, 2 to 6 percent slopes (SkB).—This soil is on high terraces north of Mill Creek. The areas are between Sublimity and Aumsville.

Representative profile along the Stayton-Sublimity Highway and 35 feet east of the center of the highway (SW¼NE¼ sec. 3, T. 9 S., R. 1 W.):

Ap—0 to 5 inches, very dark brown (7.5YR 2/2) silty clay loam, dark brown (10YR 4/3) when dry; weak, very coarse, prismatic structure breaking to moderate, fine and very fine, granular; friable, slightly hard, plastic and sticky; abundant roots; many, fine and very fine, interstitial pores; strongly acid (pH 5.2); abrupt, smooth boundary. (5 to 9 inches thick.)

A1—5 to 14 inches, very dark brown (7.5YR 2/2) silty clay loam, dark brown (7.5YR 4/4) when dry; weak, very coarse, prismatic structure breaking to weak, medium and coarse, subangular blocky structure that breaks, in turn, to moderate, fine and very fine, granular structure; friable, slightly hard, plastic and sticky; many roots; few thin clay films; common, very fine and fine, tubular pores; very strongly acid (pH 5.0); clear, smooth boundary. (0 to 9 inches thick.)

B1t—14 to 20 inches, dark-brown (7.5YR 4/4) heavy silty clay loam, brown (7.5YR 5/4) when dry; weak, very coarse, prismatic structure breaking to moderate, coarse and medium, subangular blocky structure; firm; slightly hard, very plastic and sticky; thin, nearly continuous clay films; common worm casts; very strongly acid (pH 5.0); clear, smooth boundary. (6 to 12 inches thick.)

B2t—20 to 29 inches, dark-brown (7.5YR 4/4) silty clay, brown (7.5YR 5/4) when dry; moderate, coarse and medium, subangular blocky structure; firm, hard, very plastic and sticky; moderately thick, continuous clay films; few, coarse, and common, fine and very fine, tubular pores; few roots; very strongly acid (pH 5.0); clear, smooth boundary. (6 to 15 inches thick.)

B3t—29 to 40 inches, dark-brown (7.5YR 4/4) silty clay, strong brown (7.5YR 5/6) when dry; few to common, fine, light-gray mottles and few, fine, strong-brown specks; weak, coarse, subangular blocky structure; firm, hard, very plastic and sticky; many thin clay films; few roots; few, fine and very fine, tubular pores; strongly acid (pH 5.2); clear, smooth boundary. (0 to 12 inches thick.)

C1—40 to 48 inches, variegated light-gray (7.5YR 7/1), yellowish-red (5YR 4/6), brown (7.5YR 5/2), and strong-brown (7.5YR 5/8) silty clay loam, reddish yellow (7.5YR 6/6) when dry; firm, very hard, plastic and sticky; thin, patchy clay films; few, fine and very fine, tubular pores; no roots; very strongly acid (pH 5.0); gradual, smooth boundary. (0 to 15 inches thick.)

IIC2—48 to 65 inches, finely variegated strong-brown (7.5YR 5/8) and dark-brown (7.5YR 3/2 and 4/4) gravelly and cobbly clay loam or silty clay loam, very pale brown (10YR 7/4) when dry; few, fine, reddish-brown mottles; massive; firm, extremely hard, plastic and sticky; no roots; very few, fine and very fine, tubular pores; thin, patchy clay films; very strongly acid (pH 5.0); the cobblestones and pebbles are so strongly weathered that they can be broken easily in the hand.

The solum ranges from 24 to 50 inches in thickness over weathered gravel, but it is more than 30 inches thick in most places. In places the A horizon is dark brown. The IIC2 horizon contains weathered pebbles of basalt and a few pebbles of hard quartzite as much as 1 inch in diameter.

Included with this soil in mapping were small areas of Nekia and Jory soils.

The available water capacity ranges from 9 to 12 inches. Permeability is slow, and fertility is low. Runoff is slow, and the hazard of erosion is slight. Roots can penetrate to a depth of 4 to 5 feet. Workability is fair, but it becomes progressively poorer as the content of moisture drops below field capacity.

This soil is used mainly for cereal grains, orchards, pasture, hay, and grass grown for seed, but a small acreage is used for strawberries, field corn, caneberries, and specialty crops. When irrigated, this soil is used for pole beans and sweet corn. (Capability unit IIe-3; woodland suitability group 3c1)

Salkum silty clay loam, 6 to 20 percent slopes (SkD).—In nearly 70 percent of the acreage, this soil has slopes of less than 12 percent. Runoff is medium, and erosion is a moderate hazard. Mapped with this soil were a few areas in which the surface layer is gravelly.

This Salkum soil is used for about the same crops as Salkum silty clay loam, 2 to 6 percent slopes, but tilling the small acreage of row crops so that excessive losses of soil are prevented is more difficult on this soil. Mechanical harvesting of vegetables and berries is not feasible. (Capability unit IIIe–2; woodland suitability group 3c1)

Salkum silty clay loam, basin, 0 to 6 percent slopes (SlB).—This soil is on foot slopes and in drainageways of old, high terraces. In winter it sometimes receives additional soil material washed from higher lying soils that are not protected by a cover crop. This material is deposited in a thin layer on the surface of this soil. Fertility is moderate, and this soil is well drained. In winter and spring, however, the additional water received from higher areas causes the water table to rise to the lower part of the subsoil. In some places small areas of McAlpin, Waldo, or Stayton soils block runoff from this soil. As a result, the water table is high for short periods during storms of high intensity. Nevertheless, water moves rapidly through this soil, and wetness is not a serious hazard to crops. Included with this soil in mapping were small areas of McAlpin, Waldo, and Stayton soils.

This Salkum soil is used for about the same crops as Salkum silty clay loam, 2 to 6 percent slopes. To make this soil more suitable for strawberries, and to make farming easier, the runoff from higher areas should be intercepted and safely diverted to other areas before it reaches this soil. (Capability unit IIe–1; woodland suitability group 3c1)

Santiam Series

The Santiam series consists of moderately well drained soils that formed in silty material over weathered gravelly alluvium or weathered basalt. These soils occur on remnants of old, high terraces along the foot slopes of low, red foothills. They have slopes of 0 to 15 percent. Elevations range from 300 to 375 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 53° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, vine maple, poison-oak, hazel, ocean-spray, trailing blackberry, wild strawberry, thimbleberry, brackenfern, and grass. Santiam soils are associated with Silverton soils.

In a typical profile, the surface layer is dark-brown silt loam about 6 inches thick. The subsurface layer is mottled, dark-brown silt loam about 7 inches thick. The subsoil is mottled, dark yellowish-brown silty clay loam about 17 inches thick. The substratum is mottled, dark grayish-brown and brown silty clay or clay that extends to a depth of 60 inches or more.

The Santiam soils are used for small grains, orchards, pasture, vegetables, berries, and grass grown for seed. They are also used as woodland.

Santiam silt loam, 0 to 3 percent slopes (SnA).—This soil occupies terrace remnants along the foot slopes of the Salem, Waldo, and Silverton Hills. It is adjacent to the valley floor.

Representative profile 15 feet south of the center of a gravel road and 475 feet east of the corner of the road (NW¼SE¼ sec. 1, T. 10 S., R. 3 W.):

Ap—0 to 6 inches, dark-brown (10YR 3/3) silt loam, pale brown (10YR 6/3) when dry; moderate, medium and fine, granular structure; friable, slightly hard, plastic and sticky; many roots; many, very fine and fine, interstitial pores; medium acid (pH 5.6); abrupt, smooth boundary. (4 to 7 inches thick.)

A3—6 to 13 inches, dark-brown (10YR 3/3) silt loam, pale brown (10YR 6/3) when dry; contains common, fine and very fine, faint, very dark grayish-brown (10YR 3/2) mottles when moist; weak, very coarse, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; friable, slightly hard, plastic and sticky; many roots; many, fine and very fine, tubular pores; few pebbles; medium acid (pH 5.6); abrupt, smooth boundary. (6 to 10 inches thick.)

B21t—13 to 22 inches, dark yellowish-brown (10YR 4/4) silty clay loam, pale brown (10YR 6/3) when dry; contains many, medium and fine, faint, dark grayish-brown mottles; common, fine, black stains and concretions; weak, very coarse, prismatic structure breaking to moderate, medium and fine, subangular blocky structure; friable, hard, plastic and sticky; common roots; many, fine and very fine, tubular pores; few pebbles; few thin clay films; peds thinly coated with gray silt and very fine sand; strongly acid (pH 5.4); gradual, wavy boundary. (6 to 10 inches thick.)

B22t—22 to 30 inches, dark yellowish-brown (10YR 4/4) heavy silty clay loam, light yellowish brown (10YR 6/4) when dry; contains common, fine and medium, faint, dark-brown (10YR 3/3) mottles and common black mottles; thick, grayish-brown (10YR 5/2), silty coatings on ped surfaces, light gray (10YR 7/2) when dry; weak, fine, prismatic structure breaking to moderate, fine and medium, subangular and angular blocky structure; firm, very hard, plastic and sticky; few roots; many, medium, fine and very fine, tubular pores; few pebbles; common, moderately thick clay films; strongly acid (pH 5.2); clear, smooth boundary. (8 to 14 inches thick.)

IIC—30 to 60 inches, dark grayish-brown (10YR 4/2) and brown (10YR 4/3) silty clay or clay, pale brown (10YR 6/3) and light gray (10YR 7/1) when dry; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; massive; firm, very hard, very plastic and very sticky; few roots; common, fine and very fine, tubular pores; medium and coarse, light-colored sand grains and few medium-sized pebbles that increase in number with depth; strongly acid (pH 5.2).

The A horizon ranges from dark brown to brown in color. The B horizon is dark brown to dark yellowish brown, and it contains mottles that range from faint to distinct in contrast. In places the color of the A and B horizons is slightly redder than shown in the typical profile. Texture of the B horizon ranges from silty clay loam to light silty clay or clay, with a weighted average of 35 to 42 percent clay. In places strongly weathered and unweathered pebbles make up as much as 15 percent, by volume, of the lower part of the B horizon. Depth to the C horizon ranges from 24 to 40 inches, and depth to bedrock is more than 40 inches. In places the C horizon consists of highly weathered basalt tuffs, or of gravelly material that has a matrix of clay.

Included with this soil in mapping were small areas that have a strong-brown surface layer, and small areas of a well-drained soil.

The available water capacity ranges from 8 to 11 inches. Permeability is moderately slow in the B horizon and slow in the C horizon. Fertility is moderate. This soil receives extra water as the result of seepage from higher areas, and it contains a perched water table in winter and spring. Runoff is slow, and erosion is not apparent. Below 22 to 30 inches, the depth to which roots can penetrate is restricted by excess moisture and by the clayey texture of the soil material. Workability is good.

When not irrigated, this soil is used mainly for small grains, orchards, pasture, and grass grown for seed, and it is also used as woodland. It is used for pole beans, sweet corn, caneberries, and strawberries when irrigated. Because of the extra moisture received as the result of seepage, this soil is not well suited to deep-rooted crops and to crops that cannot tolerate excessive moisture. (Capability unit IIw-1; not placed in a woodland suitability group)

Santiam silt loam, 3 to 6 percent slopes (SnB).—This soil has slightly better drainage than Santiam silt loam, 0 to 3 percent slopes, but it is used for about the same crops. Runoff is slow, and the hazard of erosion is slight. Drainage is needed for deep-rooted crops and for crops that cannot tolerate excessive moisture. (Capability unit IIe-1; not placed in a woodland suitability group)

Santiam silt loam, 6 to 15 percent slopes (SnC).—This soil has better drainage than Santiam silt loam, 0 to 3 percent slopes. Runoff is medium, and erosion is a moderate hazard.

This soil is used mainly for small grains, pasture, hay, and grass grown for seed, but a small acreage is used as woodland or for orchards, vegetables, and berries. Growing row crops or tilling so that excessive soil losses are prevented is difficult, and mechanical harvesting of vegetables and berries is not feasible. Drainage is needed for deep-rooted crops and for crops that cannot tolerate excessive moisture. (Capability unit IIIe-1; not placed in a woodland suitability group)

Semiahmoo Series

The Semiahmoo series consists of poorly drained organic soils that formed in partly decomposed organic material. These soils occur on the bottoms of former shallow lakes at elevations of 130 to 150 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 53° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly sedges, tussocks, and willows. Semiahmoo soils are associated with Labish soils.

In a typical profile, the surface layer is black muck about 9 inches thick. The next layer consists of very dark brown peaty muck about 21 inches thick. Below this is a layer of peat that extends to a depth of 60 inches or more.

The Semiahmoo soils are used mostly for growing vegetables.

Semiahmoo muck (So).—This soil is on the Labish Bottom. It is the only soil of the Semiahmoo series mapped in the survey area.

Representative profile one-fourth mile north of Labish Center, 100 feet east of road, and 200 feet south of Labish Ditch (NW¼SW¼ sec. 22, T. 6 S., R. 2 W.):

1—0 to 2 inches, black (10YR 2/1) muck, very dark gray (10YR 3/1) when dry; weak, very fine, granular structure; very friable, loose, nonsticky and nonplastic; many roots; many, fine, interstitial pores; medium acid (pH 6.0); abrupt, smooth boundary. (0 to 4 inches thick.)

2—2 to 9 inches, black (10YR 2/1) muck, very dark gray (10YR 3/1) when dry; weak, medium, subangular blocky structure; very friable, loose, nonsticky and nonplastic; many roots; many fine pores; medium acid (pH 6.0); clear, smooth boundary. (6 to 10 inches thick.)

3—9 to 30 inches, very dark brown (10YR 2/2) peaty muck; massive; very friable, soft, nonsticky and nonplastic; many pores; slightly acid (pH 6.2); gradual, smooth boundary. (10 to 30 inches thick.)

4—30 to 60 inches, variegated peat; massive; very friable, slightly hard, nonsticky and nonplastic; slightly acid (pH 6.4); many feet thick.

Included with this soil in mapping were small areas that have a surface layer of peaty muck; areas in which a layer of clay is at a depth of 14 to 15 inches; and areas along the boundary between the soil and mineral soils where the depth to mineral material in the substratum is less than 5 feet.

The available water capacity ranges from 13 to 30 inches. Permeability is moderate, and fertility is high. Runoff is slow, and the hazard of erosion is moderate. The depth to which roots can penetrate is limited by the high water table. This is subject to annual flooding. Workability is excellent.

This soil is well suited to onions and to other shallow-rooted crops, and it is used mainly for growing onions. A minor acreage is used for pole beans, sweet corn, mint, pasture, hay, and blackberies. Drainage is needed to keep the water table below the root zone. (Capability unit IIIw-3; not placed in a woodland suitability group)

Sifton Series

The Sifton series consists of excessively drained soils that are underlain by gravelly sand. These soils are nearly level. They occur on alluvial terraces at elevations of 100 to 600 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, vine maple, hazel, ocean-spray, poison-oak, blackberry, and brackenfern. Sifton soils are associated with Clackamas and Salem soils.

In a typical profile, the surface layer is black gravelly loam about 17 inches thick. The subsoil is dark-brown gravelly loam about 7 inches thick. The substratum is dark-brown very gravelly and cobbly sand that extends to a depth of 60 inches or more.

The Sifton soils are used for small grains, pasture, vegetables, and caneberries, and they are also used as woodland.

Sifton gravelly loam (St).—This is the only soil of the Sifton series mapped in the survey area. It is on terraces along the North Santiam River and Mill Creek.

Representative profile beside old farm buildings (SE¼SW¼ sec. 6, T. 9 S., R. 1 W.):

Ap—0 to 7 inches, black (10YR 2/1) gravelly loam, dark grayish brown (10YR 4/2) when dry; moderate, fine, granular structure; friable, soft, slightly plastic and very slightly sticky; many roots; very many, fine and very fine, interstitial pores; high content of organic matter; neutral (pH 6.9); abrupt, smooth boundary. (4 to 8 inches thick.)

A1—7 to 17 inches, black (10YR 2/1) gravelly loam, dark grayish brown (10YR 4/2) when dry; coarse and very coarse, subangular blocky structure; friable, soft, slightly plastic and slightly sticky; common, fine, tubular pores; few roots; common worm casts; high in content of organic matter; neutral (pH 6.9); clear, wavy boundary. (4 to 12 inches thick.)

B2—17 to 24 inches, dark-brown (10YR 3/3) gravelly loam, dark brown (10YR 4/3) when dry; weak, coarse, subangular blocky structure breaking to moderate.

fine, subangular blocky structure; friable, soft, plastic and slightly sticky; many, medium, fine and very fine, tubular pores; few roots; slightly acid (pH 6.2); gradual, wavy boundary. (7 to 10 inches thick.)

IIC—24 to 60 inches, dark-brown (10YR 4/3) very gravelly and cobbly sand that is mostly of basaltic origin, brown (10YR 5/3) when dry; massive; loose, nonsticky and nonplastic; medium acid; most of the soil material and fragments of basalt are at least moderately magnetic.

Color of the A horizon ranges from black to very dark brown. In places the A horizon is gravelly silt loam, and in some places the B horizon is gravelly very fine sandy loam. Pebbles and cobblestones in the solum constitute from 25 to 40 percent of the soil mass in some areas. Depth to the very gravelly material in the substratum ranges from 20 to 30 inches.

Included with this soil in mapping were small areas of Clackamas soils and small areas of cobbly, brown soils.

The available water capacity is 4 to 5 inches. Permeability is moderately rapid in the solum and very rapid in the substratum. Fertility is low. Runoff is very slow, and erosion is not a hazard. Roots can penetrate to depths of only 20 to 30 inches. Workability is only fair because of the gravel in the surface layer. Even though this soil is intensively used, it does not become compacted and the rate of infiltration remains high.

This soil is used mainly as woodland and for cereal grains, pasture, pole beans, bush beans, sweet corn, and caneberries. When irrigated, it is well suited to forage crops and other crops that require little cultivation. This soil is poorly suited to root crops, and it is unsuitable for mechanical harvesting of root crops. Tillage is hindered by the gravel in the surface layer. Irrigation is needed for adequate growth of most crops. It is essential for growing vegetables and berries, and for extending the use of pastures during the dry, warm summers. (Capability unit IIIs–1; not placed in a woodland suitability group)

Silverton Series

The Silverton series consists of well-drained soils that have formed in silty material over fine-textured material that contains gravel. These soils are on dissected terraces or on the foot slopes of low foothills. They have slopes of 2 to 20 percent. Elevations range from 225 to 300 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly Douglas-fir, vine maple, hazel, poison-oak, ocean-spray, thimbleberry, blackberry, strawberry, pathfinder, brackenfern, and bentgrass. Silverton soils are associated with Santiam and Nekia soils.

In a typical profile, the surface layer is dark-brown silt loam about 7 inches thick. The subsurface layer is dark-brown heavy silt loam about 9 inches thick. The upper part of the subsoil consists of a layer of dark-brown silty clay loam about 9 inches thick. The lower part of the subsoil is dark-brown gravelly silty clay about 12 inches thick. The substratum is fractured and partly weathered, consolidated basalt bedrock.

The Silverton soils are used mainly as woodland and for pasture, hay, orchards, caneberries, and grass grown for seed.

Silverton silt loam, 2 to 12 percent slopes (SuC).—This soil occupies remnants of old, high terraces along the foot slopes of low foothills. It is in areas adjacent to the terraces of Willamette silts.

Representative profile 2,640 feet south of the city limits of Silverton and 65 feet west of the highway that leads from Silverton to Stayton (in northeast corner of SW¼ NW¼ sec. 3, T. 7 S., R. 1 W.):

Ap—0 to 7 inches, dark-brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) when dry; moderate, medium, subangular blocky structure breaking to moderate, very fine, granular structure; friable, slightly hard, slightly plastic and slightly sticky; many roots; many interstitial pores; few, medium and fine, distinct, black concretions; medium acid (pH 5.8); clear, smooth boundary. (6 to 8 inches thick.)

A3—7 to 16 inches, dark-brown (7.5YR 3/3) heavy silt loam, brown (7.5YR 5/4) when dry; weak, medium, subangular blocky structure breaking to moderate, fine and very fine, subangular blocky structure; friable, slightly hard, slightly plastic and slightly sticky; many roots; many interstitial pores, and many, very fine, tubular pores; common gray coatings of silt on some vertical surfaces of peds; few, medium and fine, dark-colored concretions; common, medium, black sand grains; 3 percent, by volume, fine pebbles; medium acid (pH 6.0); clear, smooth boundary. (4 to 10 inches thick.)

B21t—16 to 25 inches, dark-brown (7.5YR 3/3) silty clay grains; 3 percent, by volume, fine pebbles; medium loam, brown (7.5YR 5/4) when dry; moderate, fine and very fine, subangular blocky structure; firm, hard, plastic and sticky; many roots; few coatings of silt on the surfaces of peds; many, fine and very fine, tubular pores; few thin clay films in pores; common, medium and fine, dark-colored concretions; common, medium, black sand grains; 3 percent, by volume, fine pebbles and cobblestones; medium acid (pH 5.9); clear, wavy boundary. (5 to 12 inches thick.)

IIB22t—25 to 37 inches, dark-brown (7.5YR 4/3) gravelly silty clay, light brown (7.5YR 6/4) when dry; moderate, medium, subangular blocky structure breaking to strong, very fine, subangular blocky structure; firm, very hard, plastic and sticky; few roots; many, fine and very fine, tubular pores; thin, nearly continuous clay films; common coarse and medium sand grains; 20 percent, by volume, pebbles and partly weathered cobblestones; medium acid (pH 5.8); abrupt, wavy boundary. (5 to 15 inches thick.)

IIIR—37 inches, fractured and partly weathered, consolidated basalt bedrock.

Depth to the nonconforming IIB22t horizon ranges from 15 to 30 inches. As much as 50 percent of this horizon is coarse fragments that are mostly strongly weathered. Depth to weathered basalt ranges from 20 to 40 inches, but it is more than 30 inches in most places.

Included with this soil in mapping were small areas of Jory and Nekia soils.

The available water capacity is 5 to 7 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and the hazard of erosion is slight. Roots can penetrate to depths of 20 to 40 inches. Workability is generally good, but it is variable where this soil is near areas of Jory and Nekia soils.

This soil is used mainly as woodland and for pasture, orchards, caneberries, and grass grown for seed. When irrigated, a small acreage is used for strawberries, sweet corn, and pole beans. (Capability unit IIe–3; woodland suitability group 3c1)

Silverton silt loam, 12 to 20 percent slopes (SuD).—Runoff from this soil is medium, and erosion is a moderate hazard. Included in mapping were small areas of Witzel soils.

This Silverton soil is used mainly for small grains, pasture, hay, and grass grown for seed, but a small acreage is used for strawberries, for cherries, or as woodland. Crops are difficult to cultivate and harvest. Cultivation and harvesting of row crops require practices that are difficult to apply without causing excessive soil losses and damage to the crops. The strong slopes and the water received from higher areas intensify the hazard of erosion. (Capability unit IIIe–2; woodland suitability group 3c1)

Stayton Series

The Stayton series consists of well-drained soils that have formed in alluvium underlain by basalt. These soils are on foot slopes and in drainageways of the red foothills. They have slopes of 0 to 7 percent. Elevations range from 250 to 1,200 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 50° to 53° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly oak, vine maple, sedges, and grass. Stayton soils are associated with Nekia and Jory soils.

In a typical profile, the surface layer is black silt loam about 17 inches thick. Just below the surface layer is a layer of dark reddish-brown silt loam about 3 inches thick. Hard basalt bedrock is at a depth of about 20 inches.

The Stayton soils are used mainly for pasture, for grass grown for seed, and as woodland.

Stayton silt loam, 0 to 7 percent slopes (SvB).—This soil is in drainageways and on foot slopes of the red foothills. It is the only soil of the Stayton series mapped in the survey area.

Representative profile 150 to 200 yards north of Drift Creek where that creek flows under Drift Creek Road; about 1½ miles south of Drift Creek Falls (NW¼SW¼ sec. 17, T. 8 S., R. 1 E.):

A11—0 to 12 inches, black (5YR 2/1) silt loam, dark reddish brown (5YR 3/3) when dry; moderate, very fine, granular structure; very friable, slightly hard, slightly sticky and slightly plastic; plentiful roots; many, very fine, interstitial pores; medium acid (pH 5.6); gradual wavy boundary. (7 to 14 inches thick.)

A12—12 to 17 inches, black (5YR 2/1) silt loam, dark reddish brown (5YR 3/3) when dry; weak, very fine and fine, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; plentiful roots; few fine pores and common very fine pores; medium acid (pH 5.8); clear, wavy boundary. (3 to 8 inches thick.)

AC—17 to 20 inches, dark reddish-brown (5YR 3/2) silt loam, reddish brown (5YR 4/4) when dry; weak, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; common fine roots; few medium pores and common very fine pores; medium acid (pH 5.8); abrupt, wavy boundary. (0 to 6 inches thick.)

IIR—20 inches, hard basalt bedrock.

Color of the A horizon ranges from black to very dark brown. Depth to bedrock ranges from 15 to 20 inches. Where the solum is shallowest over bedrock, the AC horizon is thin or absent. Where the profile lacks an AC horizon, the A horizon rests directly on bedrock. In places bedrock crops out at the surface. A few fragments of rock the size of pebbles are scattered throughout the solum.

The available water capacity ranges from 2 to 4 inches. Permeability and fertility are both moderate. Runoff is medium, and erosion is a moderate hazard. Roots can penetrate to a depth of only 15 to 20 inches.

This soil is used for pasture, for grass grown for seed, and as woodland. It is well suited to forage plants grown for pasture and to early maturing grasses grown for seed. This soil is droughty, however, and forage plants grow well only in spring. (Capability unit VIe–1; not placed in a woodland suitability group)

Steiwer Series

The Steiwer series consists of well-drained soils on foot slopes and on low foothills. These soils have formed in a thin mantle of material consisting partly of silty alluvium and colluvium and partly of sedimentary material derived from the underlying bedrock. They have slopes of 3 to 40 percent. Elevations range from 250 to 650 feet. The average annual precipitation is between 40 and 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly oak, wild rose, poison-oak, annual bromegrass, and velvetgrass. Steiwer soils are associated with Chehulpum and Hazelair soils.

In a typical profile, the surface layer is about 17 inches thick and consists of very dark brown silt loam in the upper part and of very dark grayish-brown silt loam in the lower part. A subsurface layer of dark-brown silt loam, about 4 inches thick, is just beneath the surface layer. The subsoil is dark yellowish-brown silty clay loam about 11 inches thick. Fine-grained sandstone is at a depth of about 32 inches.

Steiwer soils are used mainly as woodland and for small grains, pasture, hay, and grass grown for seed.

Steiwer silt loam, 3 to 6 percent slopes (SwB).—This soil is on low foothills and on foot slopes of the Salem and Waldo Hills.

Representative profile in a field just south of a barn, about 30 feet south of the center of a road (NW¼NE¼ sec. 25, T. 9 S., R. 3 W.):

Ap1—0 to 5 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; cloddy, breaking to very weak, coarse, granular structure; friable, hard, slightly plastic and slightly sticky; common roots; many interstitial pores; many wormholes and worm casts; common, very fine, black concretions; common very fine fragments of weathered rock; medium acid (pH 5.6); abrupt, smooth boundary. (4 to 8 inches thick.)

Ap2—5 to 8 inches, very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) when dry; massive, breaking to very weak, coarse, subangular blocky structure; friable, hard, slightly plastic and slightly sticky; few, very fine and fine, tubular pores; common, very fine, black concretions; common fine fragments of weathered rock; medium acid (pH 5.9); clear, smooth boundary. (0 to 4 inches thick.)

A1—8 to 17 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, medium, prismatic structure and moderate to strong, coarse and medium, subangular blocky structure; very friable, slightly hard, slightly plastic and slightly sticky; few roots; common, very fine and fine, tubular pores; very few, fine, black concretions; medium acid (pH 5.9); clear, smooth boundary. (0 to 10 inches thick.)

A3—17 to 21 inches, dark-brown (10YR 3/3) silt loam, pale brown (10YR 6/3) when dry; weak, coarse, prismatic structure and moderate, medium, subangular blocky structure; very friable, slightly hard, slightly plastic and slightly sticky; few roots; common, very fine and fine, tubular pores; medium acid (pH 5.8); clear, smooth boundary. (0 to 8 inches thick.)

B21—21 to 29 inches, dark yellowish-brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) when dry; weak, coarse, prismatic structure breaking to moderate, coarse and medium, subangular blocky structure; firm, hard, plastic and sticky; few roots; many, very fine and fine, tubular pores; dark grayish-brown (10YR 4/2) coatings on ped surfaces; few, fine, black concretions; common medium and fine fragments of sandstone; medium acid (pH 5.9); clear, smooth boundary. (6 to 15 inches thick.)

B22—29 to 32 inches, dark yellowish-brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) when dry; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; firm, hard, plastic and sticky; few roots; many, very fine and fine, tubular pores; dark grayish-brown (10YR 4/2) coatings on ped surfaces; few very fine concretions; many, coarse, medium and fine fragments of sandstone; slightly acid (pH 6.2); abrupt, wavy boundary. (3 to 12 inches thick.)

R—32 inches, dark yellowish-brown (10YR 4/4), hard, fractured, fine-grained sandstone that is horizontally bedded.

When the soil is moist, color of the A horizon ranges from very dark grayish brown to very dark brown or dark brown, and color of the B horizon ranges from dark brown to dark yellowish brown. Texture of the A horizon ranges from silt loam to silty clay loam, and texture of the B horizon ranges from clay loam to heavy silty clay loam. The number of fragments of siltstone, sandstone, and shale ranges from few in the upper part of the solum to many (as much as 30 percent) in the lower part of the B horizon. Depth to sedimentary bedrock ranges from 20 to 40 inches, but the depth is generally between 24 and 32 inches. Where bedrock is at the greatest depth, these soils contain a clayey horizon, as much as 4 inches thick, that lies just above the bedrock.

Included with this soil in mapping were small areas of Hazelair soils.

The available water capacity ranges from 4 to 8 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and the hazard of erosion is slight. Roots can penetrate to a depth of 20 to 40 inches.

This soil is well suited to winter cereal grains, forage crops, and early maturing grasses grown for seed. It is used mainly for those crops and for improved or woodland-grass pasture. The small irrigated acreage is used to grow pole beans, sweet corn, blackberries, and strawberries. (Capability unit IIIe-3; not placed in a woodland suitability group)

Steiwer silt loam, 6 to 20 percent slopes (SwD).—This soil has slopes that are mainly steeper than 12 percent. Runoff is medium, and the hazard of erosion is moderate. Included in mapping were some areas of sandstone outcrops, and small areas of Chehulpum soils.

This Steiwer soil is used mainly for small grains, grass grown for seed, cleared pasture, hay, and woodland pasture. (Capability unit IVe-2; not placed in a woodland suitability group)

Steiwer and Chehulpum silt loams, 3 to 40 percent slopes (SCE).—This undifferentiated unit consists of gently sloping to steep Steiwer and Chehulpum soils that are moderately deep and shallow over bedrock. Some areas consist wholly of Steiwer soils, others consist wholly of Chehulpum soils, and still others consist of both soils. The soils are on foot slopes and foothills. In areas that are not cultivated, the vegetation is mainly velvetgrass, annual bromegrass, poison-oak, rose, and oak trees.

The profile of the Steiwer soil is similar to the one described as typical for Steiwer silt loam, 3 to 6 percent slopes, except that bedrock is at a depth of only 20 to 24 inches. A representative profile of the Chehulpum soil follows:

Representative profile 25 feet south of county road NE¼NE¼NE¼ sec. 25, T. 9 S., R. 2 W.):

O1&O2—½ inch to 0, grass and leaves in varying degrees of decomposition.

A11—0 to 4 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, medium, subangular blocky and moderate, fine, granular structure; friable, slightly hard, sticky and plastic; many roots; many, very fine, interstitial and tubular pores; medium acid (pH 5.9); clear, smooth boundary. (2 to 6 inches thick.)

A12—4 to 12 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, medium and fine, subangular blocky structure; friable, hard, sticky and plastic; many roots; many, very fine and fine, tubular pores; common fine fragments of sandstone; medium acid (pH 5.9); abrupt, smooth boundary. (6 to 14 inches thick.)

IIR—12 inches, horizontally bedded, fine-grained sandstone.

Texture throughout the profile ranges from silt loam to loam. In places the A horizon is dark brown. Depth to bedrock ranges from 10 to 20 inches.

Included with these soils in mapping were small areas of Hazelair, Witzel, and Nekia soils, and many areas of rock outcrops.

The available water capacity of the Steiwer soil of this undifferentiated unit is 4 to 5 inches, and that of the Chehulpum soil is 2 to 4 inches. Permeability of the Steiwer soil is moderately slow, and that of the Chehulpum soil is moderate. Runoff is medium to rapid, and the hazard of erosion is severe. Roots can penetrate to a depth of 20 to 24 inches in the Steiwer soil, but to a depth of only 10 to 20 inches in the Chehulpum soil.

This undifferentiated unit is mainly in native pasture (fig. 9) and in wooded areas. Most of the forage is produced in spring, for the forage plants make little growth in summer and fall. These soils are not suited to Douglas-fir. Douglas-fir grows only where additional soil material has been deposited on the surface of these soils, or it grows on deeper included soils. (Capability unit VIe-1; not placed in a woodland suitability group)

Stony Rock Land

Stony rock land (Sy) is a miscellaneous land type in which 25 percent or more of the acreage is nearly bare and very stony or consists of outcrops of basalt. This land type is nearly level to very steep. Except where some areas have a sparse cover of forage plants or of stunted trees that grow where there are small pockets of soil material, the land has no value for farming. (Capability unit VIIIs-1; not placed in a woodland suitability group)

Terrace Escarpments

Terrace escarpments (Te) consists of gravelly and silty alluvium that is too variable in characteristics to be classified as soil. It is moderately steep or steep and occurs along the sidewalls of the major streams, on terrace scarps, and on the side slopes bordering channels of intermittent streams. The vegetation is mainly Douglas-fir, maple, hazel, swordfern, brackenfern, poison-oak, tussock, sedges, and grasses.

This land type is suitable for pasture and for use as woodland. The short, steep slopes make tillage impracticable. (Capability unit VIe–2; not placed in a woodland suitability group)

Waldo Series

The Waldo series consists of poorly drained soils that have formed in alluvium. These soils are nearly level. They are on bottom lands along small streams and in drainageways that dissect low foothills. Elevations range from 250 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 190 to 210 days. In areas that are not cultivated, the vegetation is mainly sedges, grasses, willow, cottonwood, ash, and oak. Waldo soils are associated with Abiqua and McAlpin soils.

In a typical profile, the surface layer is very dark grayish-brown silty clay loam that is mottled in the lower part and is about 10 inches thick. The subsoil is mottled throughout and is about 36 inches thick. It is very dark grayish-brown clay in the upper part, dark-gray clay in the middle part, and gray silty clay in the lower part. The substratum is mottled gray silty clay that extends to a depth of 60 inches or more.

The Waldo soils are used mainly for small grains, pasture, and grass grown for seed.

Waldo silty clay loam (Wa).—This is the only soil of the Waldo series mapped in the survey area. It occupies narrow strips along small streams and in drainageways of the Salem, Waldo, and Silverton Hills.

Representative profile 475 feet west and 175 feet south of the center of a gravel road that crosses over Beaver Creek (SE¼NE¼ sec. 29, T. 8 S., R. 1 W.):

Ap1—0 to 2 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 4/2) when dry; moderate, very fine, granular structure; friable, slightly hard, plastic and sticky; many interstitial pores; many, fine, reddish-brown and black concretions; medium acid (pH 5.6); abrupt, smooth boundary. (0 to 3 inches thick.)

Ap2—2 to 7 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (10YR 4/2) when dry; cloddy, breaking to very weak, fine, granular structure; very firm, very hard, plastic and sticky; few roots; few interstitial and very fine, tubular pores; many, fine, reddish-brown and black concretions; medium acid (pH 5.7); abrupt, smooth boundary. (4 to 7 inches thick.)

A1—7 to 10 inches, very dark grayish-brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; common, medium, distinct, dark gray (10YR 4/1), very dark gray (10YR 3/1), and red (2.5YR 4/8) mottles; strong, medium and fine, granular structure; friable, hard, plastic and sticky; common roots; many interstitial pores; many, coarse, medium and fine, reddish-brown and black concretions; medium acid (pH 5.8); abrupt, wavy boundary. (2 to 4 inches thick.)

B1—10 to 15 inches, very dark grayish-brown (10YR 3/2) clay, gray (10YR 5/1) when dry; common, medium, distinct, very dark gray (10YR 3/1) and yellowish-red (5YR 5/8) mottles; strong, coarse, subangular blocky structure breaking to strong, very fine, subangular blocky structure; firm, very hard, very plastic and very sticky; common roots; many, very fine and fine, tubular pores; thin coatings of silt on the surfaces of peds; many, fine and very fine, reddish-brown and black concretions; slightly acid (pH 6.1); clear, wavy boundary. (3 to 8 inches thick.)

B21g—15 to 23 inches, dark-gray (N 4/0) clay, gray (N 5/0) when dry; common, medium, distinct, strong-brown (7.5YR 5/8) mottles; strong prismatic structure breaking to strong, coarse, subangular blocky structure; very firm, very hard, very plastic and very sticky; common roots; many, very fine and fine, tubular pores; thin coatings of silt on the surfaces of peds; many, fine, reddish-brown and black concretions; medium acid (pH 5.9); clear, smooth boundary. (6 to 10 inches thick.)

B22g—23 to 37 inches, dark-gray (N 4/0) clay, gray (N 5/0) when dry; many, medium, prominent, strong-brown (7.5YR 5/8) mottles; strong prismatic structure breaking to moderate, coarse, subangular blocky structure; firm, very hard, very plastic and very sticky; common roots; many, very fine and fine, tubular pores; few, fine, reddish-brown and black concretions; medium acid (pH 5.8); gradual, smooth boundary. (11 to 17 inches thick.)

B3g—37 to 46 inches, gray (N 5/0) silty clay, gray (N 6/0) when dry; many, prominent, strong-brown (7.5YR 5/8) and yellowish-red (5YR 4/8) mottles; weak, coarse, subangular blocky structure; firm, very hard, very plastic and very sticky; few roots; few, very fine, tubular pores; few, moderately thick, gray clay films in the larger pores; few, fine, reddish-brown and black concretions; medium acid (pH 5.7); gradual, smooth boundary. (6 to 12 inches thick.)

Cg—46 to 60 inches, gray (N 5/0) silty clay, gray (N 6/0) when dry; many, medium, prominent, strong-brown (7.5YR 5/8) mottles; massive; friable, very hard, very plastic and very sticky; very few roots; common, very fine, and very few, medium, tubular pores; thick, continuous clay films in cracks, pores, and root channels; few, medium, black concretions; medium acid (pH 5.7).

In the A horizon and the upper part of the B horizon, thickness of the soil material that is as dark as very dark grayish brown is less than 24 inches. Color of the B horizon ranges from very dark grayish brown to gray. Structure in the B1 and B2 horizons ranges from moderate to strong prismatic and subangular blocky or blocky. Depth to the clay or silty clay of the B horizon is less than 25 inches. In some places mottling is near the surface. In others it is at a depth of as much as 15 inches.

Included with this soil in mapping were small areas of McAplin soils and small areas of very poorly drained soils.

The available water capacity is 9 to 11 inches. Permeability is slow, and fertility is moderate. Runoff is slow, and erosion is not a hazard. Depth to which roots can penetrate is limited by a seasonal high water table. Workability is fair, but it becomes progressively poorer as the content of moisture drops below field capacity.

This soil is used mainly for small grains, pasture, and grass grown for seed. When irrigated, areas that are drained are used for pole beans and sweet corn. Surface drainage and subsurface drainage are both needed, but establishing outlets is necessary in most places. Even after adequate surface drainage has been installed, subsurface drainage it still difficult. (Capability unit IIIw–2; not placed in a woodland suitability group)

Wapato Series

The Wapato series consists of poorly drained soils that have formed in mixed alluvium. These soils are nearly level. They occur in depressions and overflow channels on flood plains at elevations of 100 to 650 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is about 53° F., and the length of the

Figure 9.—Clearing an area for pasture on Steiwer and Chehulpum silt loams, 3 to 40 percent slopes. Typical vegetation on these soils is oak trees and annual grasses.

frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly willow, ash, tussocks, sedges, and grasses. Wapato soils are associated with McBee and Bashaw soils.

In a typical profile, the surface layer is mottled very dark brown silty clay loam about 16 inches thick. The subsoil is mottled very dark grayish-brown silty clay loam about 20 inches thick. The substratum is mottled dark-brown silty clay loam that extends to a depth of 60 inches or more.

The Wapato soils are used mainly for pasture, hay, small grains, vegetables, and caneberries.

Wapato silty clay loam (Wc).—This is the only soil of the Wapato series mapped in the survey area. It occurs in backwater areas of the flood plains, in most places adjacent to the terraces.

Representatives profile (SE¼NE¼ sec. 15, T. 6 S., R. 1 W.):

Ap—0 to 6 inches, very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) when dry; few, fine, faint, yellowish-brown (10YR 5/4) mottles; cloddy; moderate, fine, subangular blocky structure; friable, hard, sticky and plastic; many roots; common, fine, tubular pores; few reddish-brown and black concretions; slightly acid (pH 6.2); clear, smooth boundary. (6 to 9 inches thick.)

A1—6 to 16 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; common, fine, distinct, dark reddish-brown (5YR 3/4) mottles; moderate, medium, subangular blocky structure; firm, hard, sticky and plastic; many roots; many, fine, tubular pores; many reddish-brown concretions; slightly acid (pH 6.4); gradual, smooth boundary. (6 to 10 inches thick.)

B2—16 to 36 inches, very dark grayish-brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 5/2) when dry; few, fine, faint, dark-gray (10YR 5/1) mottles; weak, coarse, subangular blocky structure; firm, hard, sticky and plastic; common roots; many, fine, tubular pores; few, fine, reddish-brown and black concretions; slightly acid (pH 6.2); clear, smooth boundary. (14 to 20 inches thick.)

C—36 to 60 inches, dark-brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) when dry; many, medium, prominent, grayish-brown (2.5Y 5/2) mottles; massive; friable, hard, sticky and plastic; many, fine, tubular pores; common black concretions and stains; slightly acid (pH 6.2).

Color of the A horizon ranges from very dark brown to very dark grayish brown. In places the B horizon is dark grayish brown. Texture of the B horizon ranges from silty clay loam to light silty clay. Texture of the C horizon ranges from clay loam or silty clay loam to light silty clay. In some places this soils is mottled at or near the surface. In others mottling is at depths of as much as 12 inches.

Included with this soil in mapping were small areas of better drained soils, and small areas of a soil that has a surface layer of silt loam.

The available water capacity is 10 to 12 inches. Permeability is moderately slow, and fertility is moderate. Runoff is slow, and erosion is not a hazard or is only a slight hazard. The depth to which roots can penetrate is restricted by a high water table during winter and spring. Workability is good where the content of organic matter is adequate. Overflow occurs during winter and early in spring.

Undrained areas of this soil are used for pasture and hay. Drained areas are used for small grains, sweet corn, pole beans, hops, and blackberries. Irrigation is needed for vegetables to be grown commercially. It is also needed to make this soil better suited to forage plants and to extend the period during which these plants produce forage. Drainage is needed for most crops. Adequate outlets for surface runoff are needed. Subsurface tile drainage is needed to lower the water table for deep-rooted crops and to make tillage possible early in spring. Providing drainage for deep-rooted crops is of questionable value in most areas, however, for adequate drainage generally cannot be maintained during winter and spring. (Capability unit IIIw-2; not placed in a woodland suitability group)

Whetstone Series

The Whetstone series consists of well-drained soils that have formed in till and colluvium from basalt and tuffs. These soils are on mountainous uplands. They are underlain by basalt and have slopes of 3 to 75 percent. Elevations range from 3,000 to 4,000 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is 41° to 45° F., and the length of the frost-free season is 90 to 110 days. The vegetation is mainly noble fir, silver fir, hemlock, Douglas-fir, blue huckleberry, rhododendron, fireweed, and beargrass. Whetstone soils are associated with Henline, Kinney, and Horeb soils.

In a typical profile, the surface layer is dark-gray stony sandy loam that is only about 1 inch thick. This is covered with a thin layer of undecomposed and partly decomposed tree limbs, twigs, leaves, needles, and grass. The subsoil is about 18 inches thick, and it consists of dark reddish-brown stony loam in the upper part and of dark-brown stony loam in the lower part. The substratum is dark yellowish-brown stony loam. It is underlain by basalt bedrock at a depth of about 38 inches.

Whetstone stony loam, 3 to 25 percent slopes (WHE).—This soil occupies large areas on the middle slopes of the slopes of the Cascade Mountains. Some of the areas are steep.

Representative profile 50 feet north of a steel gate at junction of roads (NE¼NE¼ sec. 9, T. 8 S., R. 3 E.):

O1—4 to 2 inches, undecomposed limbs, twigs, leaves, needles, and grass.
O2—2 inches to 0, partly decomposed plant and animal matter.
A2—0 to 1 inch, dark-gray (5YR 4/1) stony sandy loam, gray (5YR 5/1) when dry; single grain; friable, soft, nonsticky and nonplastic; many, fine, interstitial pores; many roots; extremely acid (pH 4.0); abrupt, wavy boundary. (½ to 1½ inches thick.)
B21ir—1 to 5 inches, dark reddish-brown (5YR 3/3) stony loam, reddish brown (5YR 4/4) when dry; massive; weakly cemented; firm, hard, slightly sticky and nonplastic; common roots; 20 percent, by volume, cobblestones, other stones, and pebbles; common fine and very fine pores; dark coatings of iron on incipient surfaces of peds; dark reddish-brown (2.5YR 2/4) stains of organic matter; extremely acid (pH 4.2); abrupt, wavy boundary. (3 to 8 inches thick.)
B22ir—5 to 19 inches, dark-brown (7.5YR 3/2) stony loam, brown (7.5YR 5/4) when dry; massive; friable, hard, slightly sticky and nonplastic; common roots; common fine and very fine pores; 30 percent, by volume, cobblestones, other stones, and pebbles; bands of iron accumulation 1 to 2 inches thick along planes of weakness of incipient surfaces of peds; many, dark reddish-brown, firm nodules 5 to 25 millimeters in diameter; very strongly acid (pH 4.6); clear, wavy boundary. (12 to 16 inches thick.)
C—19 to 38 inches, dark yellowish-brown (10YR 4/4) stony loam, brown (10YR 5/3) when dry; massive; friable, slightly hard, slightly sticky and nonplastic; few roots; common fine and very fine pores; 40 percent, by volume, cobblestones, other stones, and pebbles; very strongly acid (pH 4.6).
R—38 inches, basalt bedrock.

The A2 horizon appears to be intermittent because it has been destroyed by burning or logging in many places. It is present wherever the original surface layer is present. The B horizon ranges from dark reddish brown to dark brown in color, and it has firm or friable consistence. Thickness of the B horizon ranges from 15 to 24 inches. The content of cobblestones, other stones, and pebbles in that horizon is less than 50 percent. Depth to bedrock ranges from 20 to more than 40 inches.

Included with this soil in mapping were areas that are deeper over bedrock than typical and that have only a trace of the dark-gray surface layer remaining. Also included were areas where the dark-gray surface layer is missing. Other inclusions consist of a few rock outcrops.

The available water capacity is 3 to 6 inches. Permeability is moderate, and fertility is low. Runoff is medium, and the hazard of erosion is moderate. Roots can penetrate to a depth of 20 to 40 inches.

This soil is well suited to forest trees, and it is used mainly for growing timber. It is not suited to cultivated crops. Snow usually covers the surface in winter and early in spring. (Capability unit VIe-2; woodland suitability group 3o2)

Whetstone stony loam, 25 to 55 percent slopes (WHF).—Runoff from this soil is rapid, and the hazard of erosion is severe. Rock outcrops are common.

Included with this soil in mapping were areas of Henline soils. The included areas make up from 5 to 10 percent of the acreage in this mapping unit.

This Whetstone soil is used mainly for growing timber. (Capability unit VIe-2; woodland suitability group 3r3)

Whetstone stony loam, 55 to 75 percent slopes (WHG).—Runoff from this soil is very rapid, and the hazard of erosion is very severe. Rock outcrops are numerous, and rock escarpments are common.

Included with this soil in mapping were areas of Henline soils. The included areas make up from 10 to 15 percent of the acreage in this mapping unit.

This Whetstone soil is used mainly for growing timber. (Capability unit VIIe-1; woodland suitability group 3r4)

Willamette Series

The Willamette series consists of deep, well-drained soils that have formed in silty alluvium. These soils are on low, broad valley terraces. They have slopes of 0 to 12 percent. Elevations range from 150 to 350 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 50° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly oatgrass and other native grasses, hazel, blackberry, Oregon white oak, and Douglas-fir. Willamette soils are associated with Woodburn soils.

In a typical profile, the surface layer is very dark grayish-brown silt loam about 12 inches thick. A subsurface layer that also consists of very dark grayish-brown silt loam and that is about 5 inches thick is just beneath the surface layer. The upper part of the subsoil is dark-brown silt loam about 7 inches thick; the middle part of the subsoil is dark-brown silty clay loam about 14 inches thick; and the lower part is dark-brown silt loam about 16 inches thick. A substratum of dark yellowish-brown silt loam underlies the subsoil, and it extends to a depth of 65 inches or more.

The Willamette soils are used mainly for small grains, pasture, hay, orchards, berries, and vegetables.

Willamette silt loam, 0 to 3 percent slopes (WlA).—This soil is on broad valley terraces that lie between the flood plains of the North Santiam, Santiam, and Willamette Rivers and the red foothills. The areas are between Marion and Aurora.

Representative profile (NW¼NE¼SE¼ sec. 22, T. 5 S., R. 1 W.):

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many, fine, tubular pores; few reddish-brown and black concretions; slightly acid (pH 6.1); clear, smooth boundary. (5 to 7 inches thick.)

A1—6 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, coarse and medium, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; common, very fine and fine, tubular pores; iron stains along root channels; common, fine, reddish-brown and black concretions; slightly acid (pH 6.1); clear, smooth boundary. (4 to 8 inches thick.)

A3—12 to 17 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) when dry; moderate, medium, subangular blocky structure; friable, hard, slightly sticky and slightly plastic; common roots; common, very fine and fine, tubular pores; common, medium and fine, reddish-brown and black concretions; slightly acid (pH 6.2); clear, smooth boundary. (3 to 12 inches thick.)

B1t—17 to 24 inches, dark-brown (10YR 3/3) silt loam, dark brown (10YR 4/3) when dry; moderate, medium, subangular blocky structure; friable, hard, sticky and slightly plastic; common roots; common, very fine and fine, tubular pores; few thin clay films; common, medium and fine, reddish-brown and black concretions; strong-brown (7.5YR 3/2) coatings on ped surfaces; few black stains; slightly acid (pH 6.2); gradual, smooth boundary. (7 to 11 inches thick.)

B2t—24 to 38 inches, dark-brown (10YR 3/3) silty clay loam, dark yellowish brown (10YR 4/4) when dry; moderate, coarse, subangular blocky structure; friable, hard, sticky and plastic; common roots; common, very fine, tubular pores; medium, continuous clay films; dark-brown (10YR 4/3) mottles and common gray coatings of silt on ped surfaces (10YR 5/1); few reddish-brown and black concretions; slightly acid (pH 6.2); gradual, smooth boundary. (10 to 14 inches thick.)

B3t—38 to 54 inches, dark-brown (10YR 3/3) silt loam, dark yellowish brown (10YR 4/4) when dry; moderate, coarse, subangular blocky structure; friable, hard, slightly sticky and slightly plastic; few roots; common, very fine, tubular pores; medium, patchy clay films; few reddish-brown and black concretions; slightly acid (pH 6.4); gradual, smooth boundary. (6 to 18 inches thick.)

C—54 to 65 inches, dark yellowish-brown (10YR 4/4) silt loam, brown (10YR 5/3) when dry; massive; friable, hard, slightly sticky and slightly plastic; common, very fine, tubular pores; slightly acid (pH 6.5).

The A horizon ranges from 15 to 25 inches in thickness and from very dark brown or dark brown to very dark grayish brown in color. The B horizon ranges from silty clay loam to silt loam in texture and from moderate or weak, medium, prismatic to moderate subangular blocky in structure. In places the B horizon contains faint mottles in the lower part, and distinct mottles below a depth of 40 inches. The C horizon is mainly silt loam or silty clay loam that is massive, but in places it contains thin layers that have other texture or structure.

Included with this soil in mapping were areas of Amity and Woodburn soils. The areas of Amity soils make up less than 2 percent of the total acreage in the mapping unit. Those of Woodburn soils make up as much as 15 percent.

The available water capacity is 12 to 14 inches. Permeability is moderate, and fertility is high. Runoff is slow, and no apparent erosion has taken place. Internal drainage is medium. Roots can penetrate to a depth of 5 feet or more.

This soil is used mainly for small grains, field corn, orchards, pasture, hay, caneberries, strawberries, and vegetables, but it is suited to all the crops commonly grown in the survey area. Irrigation makes this soil even better suited to crops, and it improves the quality of most crops. (Capability unit I–1; not placed in a woodland suitability group)

Willamette silt loam, 3 to 12 percent slopes (WlC).—This soil has slopes of 3 to 7 percent in about 70 percent of the acreage. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

Included with this soil in mapping were small areas of Woodburn soils, and small areas in which slopes are as steep as 20 percent.

This Willamette soil is used mainly for small grains, pasture, hay, and orchards, but a moderate acreage is used for vegetables and berries. This soil is less suitable for vegetables and berries than Willamette silt loam, 0 to 3 percent slopes. Mechanical harvesting of crops is difficult on slopes steeper than 5 percent. (Capability unit IIe–2; not placed in a woodland suitability group)

Witzel Series

The Witzel series consists of well-drained, very stony soils on breaks in red foothills. These soils have formed partly in loess but mainly in colluvium from basic igneous rock. They have slopes of 3 to 40 percent. Elevations range from 300 to 1,000 feet. The average annual precipitation is 40 to 60 inches, the average annual air temperature is 52°

to 54° F., and the length of the frost-free season is 190 to 200 days. The vegetation is mainly grass, poison-oak, rose, oak, and scattered Douglas-firs. Witzel soils are associated with Nekia and Jory soils.

In a typical profile, the surface layer is dark-brown very stony silt loam about 4 inches thick. The subsoil is about 15 inches thick, and it consists of dark-brown very stony silty clay loam in the upper part and of dark reddish-brown very stony silty clay loam in the lower part. Partly fractured basalt bedrock is at a depth of about 19 inches.

The Witzel soils are used mainly for pasture and as woodland.

Witzel very stony silt loam, 3 to 40 percent slopes (WtE).—This is the only soil of the Witzel series mapped in the survey area. It is on slope breaks and in red foothills. The dominant slopes are less than 12 percent.

Representative profile (NE¼SE¼ sec. 8, T. 8 S., R. 2 W.):

A1—0 to 4 inches, dark-brown (7.5YR 3/2) very stony silt loam, brown (7.5YR 5/4) when dry; moderate, fine, granular structure; friable, hard, slightly sticky and slightly plastic; 60 percent roots; many, very fine and fine, interstitial pores; many coarse fragments; medium acid (pH 6.0); clear, smooth boundary. (2 to 6 inches thick.)

B21—4 to 9 inches, dark-brown (7.5YR 3/2) very stony silty clay loam, brown (7.5YR 5/4) when dry; moderate, fine, subangular blocky structure; firm, hard, sticky and plastic; many roots; common, very fine, tubular pores; 60 percent coarse fragments; medium acid (pH 6.0); gradual, wavy boundary. (3 to 10 inches thick.)

B22—9 to 19 inches, dark reddish-brown (5YR 3/4) very stony silty clay loam, reddish brown (5YR 5/4) when dry; weak, medium, subangular blocky structure; friable, hard, sticky and plastic; many roots; common, very fine, tubular pores; 60 percent coarse fragments; medium acid (pH 6.0); clear, smooth boundary, (2 to 6 inches thick.)

IIR—19 inches, partly fractured basalt bedrock.

The A horizon ranges from silt loam to silty clay loam or clay loam in texture, and in places the B horizon is clay loam. Color of the B horizon ranges from dark brown to dark reddish brown. Thickness of the solum over basalt bedrock ranges from 12 to 20 inches. The content of coarse fragments of rock in the soil mass ranges from 50 to 75 percent.

Included with this soil in mapping were some areas in which bedrock is as deep as 30 inches.

The available water capacity is 1 to 3 inches. Permeability is moderately slow, and fertility is low. Roots can penetrate to a depth of 12 to 20 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high.

This soil is not used for cultivated crops, but it is used mainly for native pasture and as woodland. The high content of stones, low available water capacity, and hazard of erosion make this soil poorly suited to use for pasture. (Capability unit VIs–1; not placed in a woodland suitability group)

Woodburn Series

The Woodburn series consists of moderately well drained soils that have formed in silty alluvium and loess of mixed mineralogy. These soils are on broad valley terraces. They have slopes of 0 to 20 percent. Elevations range from 150 to 350 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 52° to 54° F., and the length of the frost-free season is 200 to 210 days. In areas that are not cultivated, the vegetation is mainly grass and Douglas-fir. Woodburn soils are associated with Willamette soils.

In a typical profile, the surface layer is about 17 inches thick and is very dark brown silt loam in the upper part and dark-brown silt loam in the lower part. The subsoil is about 37 inches thick. It is dark yellowish-brown silty clay loam in the upper part; mottled dark-brown silty clay loam in the middle part; and mottled, dark-brown silt loam in the lower part. The substratum is dark-brown silt loam that extends to a depth of 68 inches or more.

The Woodburn soils are used mainly for small grains, pasture, hay, orchards, berries, and vegetables.

Woodburn silt loam, 0 to 3 percent slopes (WuA).—This soil is on broad terraces of Willamette silts.

Representative profile about 200 feet west of the paved road to Champoeg (SW¼SE¼SE¼ sec. 2, T. 4 S., R. 2 W.; profile No. 5 in table 9 in the section "Laboratory Data."):

Ap—0 to 9 inches, very dark brown (10YR 2/2) silt loam, brown (10YR 5/3) when dry; cloddy and has very weak, subangular blocky structure; friable, slightly hard, slightly sticky and slightly plastic; many roots; many, fine and very fine, tubular pores; few, fine, interstitial pores; common, medium and fine, reddish-brown and black concretions; medium acid (pH 5.9); abrupt, smooth boundary. (6 to 10 inches thick.)

A1—9 to 17 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; moderate, medium, subangular blocky structure; friable, hard, slightly sticky and slightly plastic; common clean silt and sand grains on ped surfaces; many roots; many, very fine, tubular pores; few, thin, darker (10YR 2/2) coatings on ped surfaces; few reddish-brown and black concretions; slightly acid (pH 6.2); clear, smooth boundary. (3 to 8 inches thick.)

B21t—17 to 25 inches, dark yellowish-brown (10YR 3/4) silty clay loam, brown (7.5YR 5/4) when dry; moderate, coarse and medium, subangular blocky structure; friable, hard, sticky and plastic; common roots; many, very fine, tubular pores; few thin clay films on peds; few reddish-brown and black concretions; few black stains on ped surfaces; medium acid (pH 6.0); clear, smooth boundary. (7 to 9 inches thick.)

B22t—25 to 32 inches, dark-brown silty clay loam, brown (10YR 5/3) when dry; few, fine and medium, distinct, dark-gray (10YR 4/1) mottles, light brownish gray (10YR 6/2) when dry; moderate, medium and coarse, subangular blocky structure; friable, hard, brittle, sticky and plastic; common roots; many, very fine, tubular pores; continuous, moderately thick clay films on ped surfaces and in pores; few, fine, black concretions and stains on ped surfaces; medium acid (pH 5.8); abrupt, smooth boundary. (6 to 10 inches thick.)

B31t—32 to 39 inches, dark-brown (10YR 4/3) silt loam, brown (10YR 5/3) when dry; distinct, dark grayish-brown (10YR 4/2) mottles in a few root channels; thin, dark grayish-brown (10YR 4/2) coatings on plane surfaces, light gray (10YR 7/2) when dry; nearly massive; some planes of weakness that are indistinct; vertical planes are more distinct than horizontal planes; very firm, very hard, brittle, slightly sticky and slightly plastic; few roots; many, fine and very fine, tubular pores; continuous, moderately thick clay films on plane surfaces and in some root channels and pores; few, fine and medium, black concretions and few, black coatings on plane surfaces; medium acid (pH 5.7); gradual, smooth boundary. (7 to 10 inches thick.)

B32t—39 to 54 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; nearly massive, and has some indistinct vertical planes of weakness; very firm, very hard, brittle, slightly sticky and slightly plastic;

no roots; many, fine and very fine, and few, medium, tubular pores; continuous, thin clay films in pores and in old root channels; few black concretions, and some patchy, black coatings on plane surfaces; medium acid (pH 5.9); gradual, wavy boundary. (11 to 17 inches thick.)

C—54 to 68 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; massive; very firm, very hard, brittle, slightly sticky and slightly plastic; no roots; many, very fine, tubular pores; common moderately thick clay films in larger pores and in old root channels or worm channels; few black coatings in pores and in channels; medium acid (pH 5.9); gradual, wavy boundary. (14 to 16 inches thick.)

When the soil is moist, color of the A horizon ranges from dark grayish brown to very dark brown or dark brown, and color of the B2 horizon ranges from very dark grayish brown or dark brown to dark yellowish brown or strong brown. In all areas the A horizon is thicker than 10 inches. The B2 horizon ranges from heavy silt loam to silty clay loam in texture. Structure of the B2 horizon ranges from weak to moderate, medium or coarse, prismatic to moderate, fine to coarse, subangular blocky. Distinct mottling occurs at a depth above 30 inches. In some places the B3 horizon has weak to moderate subangular blocky or prismatic structure. In others it is massive and has vertical planes of weakness. Consistence of the B3 horizon is firm or very firm when the soil is moist. The substratum is stratified. It ranges from silty clay loam or silt loam to very fine sandy loam or fine sandy loam in texture.

Included with this soil in mapping were small areas of Amity and Willamette soils, and small areas of a somewhat poorly drained soil. The areas of Amity soils occupy less than 5 percent of the acreage in this mapping unit. The areas of Willamette soils occupy as much as 10 percent.

The available water capacity is 11 to 13 inches. Permeability is moderate in the upper part of the subsoil, and it is slow in the lower part. Fertility is high. Depth to which roots can penetrate is restricted by a seasonal perched water table and as the result of the type of structure. Runoff is slow, and no apparent erosion has taken place.

This soil is used mainly for small grains, field corn, orchards, pasture, hay, caneberries, and vegetables. Areas that are drained are used for all the crops commonly grown in the survey area. Because of the perched water table, drainage is needed for crops that cannot tolerate excessive moisture. (Capability unit IIw–1; not placed in a woodland suitability group)

Woodburn silt loam, 3 to 12 percent slopes (WuC).—This soil has slopes of 3 to 5 percent in about 60 percent of the acreage. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

Included with this soil in mapping were small areas that have a thin surface layer and that have distinct mottling within 12 inches of the surface.

This Woodburn soil is used for about the same crops as Woodburn silt loam, 0 to 3 percent slopes. It is less suitable for vegetables and berries, however, because of the difficulty of cultivating those crops so that erosion is controlled without damaging the crop. Mechanical harvesting of vegetables and berries is difficult where slopes are steeper than 5 percent. (Capability unit IIe–1; not placed in a woodland suitability group)

Woodburn silt loam, 12 to 20 percent slopes (WuD).—Where this soil occurs along creeks, intermittent drainageways, and terrace fronts, its slopes are short and abrupt. Runoff is rapid, and the hazard of erosion is moderate.

Included with this soil in mapping were small areas that have a thin surface layer and that have distinct mottling within 12 inches of the surface.

This Woodburn soil is used mainly for pasture, hay, and small grains, although some small areas are used for row crops and orchards. This soil is poorly suited to row crops, for the slopes are too short and steep for mechanical harvesting of vegetables, berries, and other row crops to be feasible. Tilling row crops so that excessive soil losses are avoided is also difficult. (Capability unit IIIe–1; not placed in a woodland suitability group)

Formation and Classification of Soils

Soils of the Marion County Area differ in fertility, in physical and chemical properties, and in productivity. These differences are the result of differences in parent material and of local differences in the environment under which the soils have formed. This section describes some factors in the environment, and major processes that have affected the formation of soils of the Marion County Area. It also defines the current system for classifying soils and shows the classification of the soils by series and by higher categories.

Formation of Soils

Soil is a natural body on the surface of the earth. It consists of mixtures of rocks and minerals that have been subjected to various degrees of weathering and that contain greatly varying amounts of organic matter, water, and air. Soils have more or less distinct horizons that have developed under the influence of local factors in the environment. The soil-forming processes that produce different kinds of soils are parent material, which affects the physical and chemical composition of the soils; climate, principally precipitation and temperature; biological forces, or the plant and animal life in and on the soil; relief, or topography; and the time in which the soil-forming processes have acted on the parent material. These five factors, in many different combinations and intensities, produce soils that differ from place to place. The influence of each soil-forming factor on the soils of the Marion County Area is described in the following paragraphs.

Parent material

Soils in the survey area have formed in eight major kinds of parent material. These are (1) recent alluvium, (2) gravelly alluvium, (3) young, silty terrace alluvium, (4) weakly consolidated, old gravelly alluvium, (5) basic colluvium from basalt and massive tuffs, (6) sedimentary alluvium and colluvium derived from tuffaceous sandstone and shale, (7) glacial till, and (8) deposits of organic material. The soils in about 80 percent of the survey area have formed in recent alluvium (Willamette silts); in basic igneous material (basic colluvium derived from basalt and massive tuffs); or in glacial till. Figure 10 shows the approximate distribution of the different kinds of parent materials in the survey area. This figure is based only partly on the results of geologic studies, and therefore it cannot be called a geologic map. The distribution shown is the result of combining information obtained

Figure 10.—**Approximate distribution of parent materials of soil in the Marion County Area:**

RA=Recent alluvium.
GA=Gravelly alluvium.
A=Young, silty terrace alluvium.
OA=Weakly consolidated, old gravelly alluvium.
BC=Basic colluvium from basalt and massive tuffs.
SC=Sedimentary alluvium and colluvium derived from tuffaceous sandstone and shale.
G=Glacial till.
O=Deposits of organic material.

when the soils were surveyed with information from studies of topography and geology by other workers.

Recent alluvium was deposited on flood plains and alluvial fans during recent times. It is of two kinds—general alluvium and local alluvium. The general alluvium was derived from various sources. The local alluvium was washed from areas underlain by basic igneous rock. Camas, Newberg, Cloquato, Chehalis, McBee, Wapato, Labish, and Bashaw soils have formed in general alluvium. Minniece, Abiqua, McAlpin, Waldo, Stayton, and Chehalem soils have formed in local alluvium derived from basalt and tuffs.

Gravelly alluvium was deposited as outwash on the Cascade Mountains during the late stages of the Pleistocene glaciation. It consists mainly of gravel and sand. The lower B horizons of the Holcomb soils, and the entire solum of the Salem, Clackamas, Sifton, and Courtney soils, appear to have formed in this gravelly material.

Young, silty terrace alluvium was deposited on flood plains, probably late in the Pleistocene epoch. It now occupies areas above the flood plains, where it receives no new sediment. This material consists of stratified sandy, silty, and clayey sediment that contains a large amount of quartz. The material near the top of the layer of alluvium appears to have been modified by ash and by other windblown deposits, and it has been subjected to slight weathering. The Amity, Concord, Dayton, Willamette, and Woodburn soils have formed in young, silty terrace alluvium. That in which the Dayton and Woodburn soils formed appears to contain some windblown material (*8*).

Weakly consolidated, old gravelly alluvium consists partly of gravelly alluvium derived from basalt, and partly of gravelly alluvium derived from a mixture of different rocks. It appears to be of a different age and composition than the recent alluvium, gravelly alluvium, and young, silty alluvium described in the preceding paragraphs. This old alluvium is extensively weathered, and it occurs as remnants of old terraces, generally on the foot slopes of low foothills. In most places these remnants are covered by a deposit of silt that is 3 to more than 5 feet thick. In an area near the town of Sublimity and extending westward for about 2 miles, however, they appear to have been influenced by local alluvium. The Santiam, Silverton, and Salkum soils have formed in these materials.

Colluvium from basalt and massive tuffs is basic. The basalt from which it is partly derived is of Miocene age and is relatively unweathered in some areas and is deeply weathered in others. The tuffs are of Pliocene age, but they appear to vary somewhat in age and in texture. In areas where the tuffs are adjacent to deposits of glacial till, they apparently have been worked by water. Soils that have formed in basic colluvium derived from basalt and tuffs are the Jory, Nekia, Witzel, and Henline.

Sedimentary alluvium and colluvium derived from tuffaceous sandstone and shale is basic, and it provides the parent material for the Chehulpum, Hazelair, Hullt, and Steiwer soils. The tuffaceous standstone and shale from which this alluvium and colluvium were derived was formed during the Oligocene or upper Eocene epoch, and it contains fossilized clamshells. Sedimentary alluvium and colluvium at the lower elevations in the survey area are relatively unweathered.

Glacial till was probably laid down at a very late stage in the glacial history of the Cascade Mountains. Although all of this material was laid down during the Pleistocene epoch, two distinct deposits—a coarse-textured, cobbly one, and a fine-textured one—have been observed. Kinney, Horeb, and Whetstone soils have formed in the coarse-textured, cobbly material. McCully and Cumley soils have formed in the fine-textured material.

Organic material was deposited in former shallow lakes and on the flood plains of those lakes during the Late Pleistocene (Wisconsin) period. The only remaining area where this material was deposited is the Lake Labish Bottom. Semiahmoo muck has formed in this organic material. Because of the anerobic conditions under which this soil formed, little development of a soil profile has taken place.

Climate

The Marion County Area has a modified marine climate. Approximately 70 percent of the annual precipitation falls during the 5 month of November through March, and less than 7 percent falls during the 3 months in summer, June through August. In the areas that are farmed, nearly all of the precipitation in winter is in the form of rain. Winters are cool and wet. Summers are moderately warm and moderately dry. Precipitation throughout the survey area is adequate each year for saturating the soils and for recharging the deep water table.

The survey area is divided into three climatic zones—the floor of the Willamette Valley, the lower foothills of the Cascade Mountains, and the middle slopes of the Cascade Mountains. Only in the highest of the three zones, the middle slopes of the Cascade Mountains, is any significant amount of snow regularly expected each year.

The amount of precipitation increases gradually, and the average annual temperature decreases, from the valley floor eastward to the low foothills of the Cascade Mountains. About 40 inches of precipitation is received each year on the floor of the valley. About 45 inches is received each year along the foot slopes of the foothill areas. From the low foothills to the middle slopes of the Cascade Mountains, the amount of precipitation ranges from 50 inches to about 70 inches. It is doubtful, however, that the differences in development of the soils between the valley floor and the middle slopes of the Cascade Mountains was caused entirely by differences in the amount of precipitation. Differences in temperature between the areas on the valley floor and the higher lying areas to the east are also not great enough to account for all the differences among the soils. In either area, freezing of the soils to a depth of more than a fraction of an inch is rare. Nevertheless, the soils that formed under the mild subhumid climate of the valley floor are less leached and have higher base saturation than the soils on the low foothills and on the middle slopes of the Cascade Mountains.

On the deep soils of the floor of the Willamette Valley, growth of plants is rapid late in spring. Growth continues at a reduced rate through the summer months, and it increases when the fall rains begin in September. As a rule, most of the soil moisture is gone from the shallow soils by the middle of July, and it is gone from the moderately deep soils by August. Mild winters, abundant moisture, and warm temperatures in spring favor the moderate oxidation of organic matter. The oxidation or loss of organic matter is offset by the long growing season, the lush growth of plants, the lack of excessive moisture, and the cool nights during summer and fall, all of which allow a moderate amount of organic matter to accumulate in the soils.

On the foothills and middle slopes of the Cascade Mountains in the eastern part of the survey area, the elevation ranges from about 350 feet to about 3,500 feet. As elevation increases, the annual precipitation increases from about 50 inches to about 90 inches. The average annual temperature at the lower elevations is about 60° F., but it decreases to about 45° F. at the highest elevations.

At the higher elevations, effects of the great amount of precipitation and the lower temperatures are evident in the kinds of plants and in differences in the soils. Plants at these higher elevations become increasingly abundant as the elevation increases, and the kinds of plants change from grasses and other plants typical of prairies to those typical of a coniferous forest. The content of organic matter in the upper part of the surface layer is greater in soils at the higher elevations than in those at lower elevations. Also, the soils in the high, mountainous areas have less distinct horizons and are more strongly acid than those in lower areas in the valley.

Biological forces

In the valley and on the deeper soils of the low foothills, the original vegetation consisted of grasses; of small scattered clumps of Douglas-fir and Oregon white oak; and of small herbaceous plants. On shallow soils of the low foothills, the vegetation was mainly grasses and scattered Oregon white oaks. Many of the herbaceous plants in the valley and on the low foothills were annuals that grew rapidly in spring and matured before warm, dry weather set in in summer. Presumably, this parklike distribution of vegetation resulted from burning by Indians over a period of many years. The surface layer of the Amity, Willamette, and Woodburn soils that formed under this lush growth of grasses and Douglas-fir is very dark brown to very dark grayish brown when the soils are moist.

In the higher foothills and on the middle slopes of the Cascade Mountains, the plant cover changes from predominantly grasses and small herbaceous plants, typical of the valley areas, to a coniferous forest, with an understory of grasses and brush. The large amount of rainfall, moderate temperature, and abundant vegetation are responsible for the high content of organic matter in the soils that occupy the middle slopes of the Cascade Mountains. At the highest elevations, where the temperature is lower than on the foot slopes or in the valley, organic matter oxidizes at a slow rate. A layer of duff, several inches thick, has formed, and it causes acid leaching of the soils, development of an A2 horizon, and the accumulation of iron oxides in the B horizon.

Relief

Relief has had an important role in the formation of the soils in the survey area. Soils that have formed in alluvial material along streams, for example, are not far above the level of the streambed. Until comparatively recent time, they received annual deposits of new material carried by floodwaters, and they are so nearly level that floodwaters do not drain away rapidly. Most of these areas are still subject to occasional overflow, and they still receive some new material from time to time as the result of flooding. The soils in these areas have a weakly developed profile because the material in which they formed has not been in place long enough for distinct horizons to have developed. Because these soils have periodically received a fresh supply of plant nutrients in newly deposited material, they have the highest fertility of any soils in the survey area.

The nearly level soils of terraces on the valley floor are drained mainly by winding channels of streams that also drain the soils on foothills and mountains to the east. As a result of the nearly level relief, the seasonal high water table, and the poor or somewhat poor natural drainage throughout the general area, poorly drained to moderately well drained soils are dominant on these terraces.

Recent alluvial fans have formed around the margins of the low foothills from sediment washed from higher slopes. Generally, the soils on these fans have been affected by seepage water from higher areas, and during winter and spring, they have a high water table.

In the low foothills, the soils are gently rolling to steep, and the amount and speed of runoff varies according to the degree of slope. Most of the soils are deep or very deep, but there are some shallow, stony soils on slope breaks and in areas where bedrock crops out. On the middle slopes of the Cascade Mountains, the soils are mainly gently sloping, are deep or moderately deep, and occupy broad ridges that break sharply toward streams and drainageways. In addition, shallow soils occupy some areas where outcrops of rock are common. Many outcrops of rock are scattered throughout the middle slopes of the Cascade Mountains.

Time

Time amounting to many thousands of years has been a factor in forming soils of the uplands, for example, those of the Jory and Nekia series. In contrast, the formation of soils on bottom lands and flood plains has been affected by only a relatively short period of time. The Camas and Newberg soils are examples of soils formed on bottom lands and flood plains. Study of the position of some soils on the various terraces and fans in the survey area establishes, to some extent, the comparative age of these soils; study of the stratification of other soils exposed in road cuts and along streams establishes the relative age of those soils; and study of the geomorphology, extent of erosion, and profiles of still other soils has made it possible to estimate their relative age.

In general, the youngest soils in the survey area are those formed in recent alluvium and in organic material. Some of the soils formed in recent alluvium—the Bashaw, Camas, Chehalis, Cloquato, Labish, McBee, Newberg, and Wapato—have formed on flood plains of the Willamette River and its larger tributaries. They have also formed on the flood plains of Butte Creek and the Santiam, North Santiam, and Pudding Rivers. Other soils—the Abiqua, Chehalem, McAlpin, Stayton, and Waldo—have formed in recent alluvium along minor streams and on alluvial fans. The Semiahmoo soils, forming in organic matter that has accumulated on the bottoms of former lakes and on the flood plains of those lakes, are of about the same age as the soils on flood plains of present-day streams.

Soils on terraces are older than those formed on flood plains in recent alluvium. They have formed in weakly consolidated, old, gravelly alluvium of three different kinds, all likely of Pleistocene age. These are Lacomb and Leffler gravels, Willamette silts, and Linn gravel. The materials that make up the highest terrace remnants are of mixed mineralogy. They are comprised of Lacomb gravel and of Leffler gravel, which are probably of early and middle Pleistocene ages, respectively. On the terrace remnants, the influence of the Leffler gravel on the formation of soils has been modified by two other materials, Linn gravel and Willamette silts, which apparently were deposited more recently on the lower terraces. Although Linn gravel is much older than the Willamette silts, the profiles of soils formed in these two materials show a similar degree of development. Salem, Sifton, Clackamas, and Courtney soils have formed mainly in material derived from Linn gravel, although the Salem and Sifton soils likely were influenced, to some extent, by more recently deposited material. Willamette, Woodburn, and Amity soils have formed in Willamette silts, and Concord, Holcomb, and Dayton soils have formed partly in Willamette silts and partly in other material (*8*).

Soils formed in material derived from old parent material are not themselves necessarily old. For example, tuffaceous sandstone and shale that occupy exposed beds on the foot slopes and low foothills of the Cascade Mountains are among the oldest parent materials in the survey area. Yet, Chehulpum, Hazelair, Hullt, and Steiwer soils that have formed in material partly derived from this tuffaceous sandstone and shale have profiles showing little or only moderate evidence of development.

The Jory, Nekia, Cumley, and McCully soils are the oldest in the survey area. They have been in place long enough for distinct horizons to have developed. These soils are on foot slopes and low foothills. They have formed in material derived from slightly to deeply weathered basalt of Miocene age and from tuffaceous material of Pliocene age. Of this group of soils, the McCully show the least development of a soil profile. They and the Cumley soils have formed in alluvium and colluvium, or in material washed downslope from areas underlain by till. Witzel soils, also on foothills but on breaks, have formed in alluvium and colluvium, and they have only a weakly developed solum.

The Henline, Horeb, Kinney, Minniece, and Whetstone soils, on the middle slopes of the Cascade Mountains, have formed in recent colluvium and in glacial till of Late Pleistocene age. Except for the Whetstone soils, which occur at the highest elevations in the survey area, all of these soils have a weakly developed profile. The Whetstone soils occur at elevations where the temperature is lower and more precipitation is received than at lower elevations, and they show distinct horizonation and development of a soil profile.

Classification of Soils

Soils are classified so that we can more easily remember their significant charactertistics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and used in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 and later revised (*11*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965 (*15*). The current system is under continual study. Therefore, readers interested in developments of the current system should search the latest literature available (*10*). In table 8 the soil series of the Marion County Area are placed in some categories of the current system.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar origin are grouped together. The classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, the Entisols, and Histosols, occur in many different kinds of climate. The seven soil orders in the Marion County Area are Vertisols, Inceptisols, Mollisols, Spodosols, Alfisols, Ultisols, and Histosols.

SUBORDER. Each order is subdivided into groups (suborders) that are based mostly on soil characteristics that seem to produce classes having the greatest similarity from the standpoint of their genesis. Suborders narrow the broad climatic range of soils that are in orders. Soil characteristics used to separate suborders mainly reflect either the presence or absence of waterlogging, or soil differences produced through the effects of climate or vegetation.

GREAT GROUP. Each suborder is divided into great groups on the basis of uniformity in the kinds and sequences of major soil horizons and other features. An example of horizons used to make separations are those in which clay, iron, or humus has eluviated or accumulated. Other features commonly used are temperature and content of moisture of the soil, and major differences in chemical composition (mainly the bases calcium, magnesium, sodium, and potassium). The great group is not shown separately in table 8, because it is the last word in the name of the subgroup.

SUBGROUP. Great soil groups are subdivided into subgroups. One of these represents the central, or typic, segment of the group. Other subgroups have properties of the group but have one or more properties of another great group, suborder, or order, and these are called intergrades. The names of subgroups are formed by placing one or more adjectives ahead of the name of the great group. An example is Cumulic Ultic Haploxerolls.

FAMILY. Families are separated within a subgroup, primarily on the basis of properties that are important to the growth of plants or to the behavior of soils used for engineering. The main properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. The names of families consist of a series of adjectives that precede the name of a subgroup. The adjectives used are the class names for soil texture, mineralogy, and so on (see table 8). An example is the coarse-silty, mixed, mesic family of Culmulic Ultic Haploxerolls.

SERIES. The series consists of a group of soils that formed from a particular kind of parent material and have genetic horizons that, except for texture of the surface layer, are similar in differentating characteristics and in arrangement in the soil profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

TABLE 8.—*Soil series classified according to the current system of classification*

Series [1]	Family	Subgroup	Suborder	Order
Abiqua	Fine, mixed, mesic	Cumulic Ultic Haploxerolls	Xerolls	Mollisols.
Amity	Fine-silty, mixed, mesic	Argiaquic Xeric Argialbolls	Albolls	Mollisols.
Bashaw	Very fine, montmorillonitic, mesic	Typic Pelloxererts	Xererts	Vertisols.
Camas	Sandy-skeletal, mixed, mesic	Fluventic Haploxerolls	Xerolls	Mollisols.
Chehalem	Fine, mixed, noncalcareous, mesic	Cumulic Haplaquolls	Aquolls	Mollisols.
Chehalis	Fine-silty, mixed, mesic	Cumulic Ultic Haploxerolls	Xerolls	Mollisols.
Chehulpum	Loamy, mixed, mesic, shallow	Entic Haploxerolls	Xerolls	Mollisols.
Clackamas	Fine-loamy, mixed, noncalcareous, mesic	Typic Argiaquolls	Aquolls	Mollisols.
Cloquato	Coarse-silty, mixed, mesic	Cumulic Ultic Haploxerolls	Xerolls	Mollisols.
Concord	Fine, montmorillonitic, mesic	Typic Ochraqualfs	Aqualfs	Alfisols
Courtney	Fine, montmorillonitic, noncalcareous, mesic	Abruptic Argiaquolls	Aquolls	Mollisols.
Cumley	Clayey, mixed, mesic	Typic Haplohumults	Humults	Ultisols.
Dayton	Fine, montmorillonitic, mesic	Typic Albaqualfs	Aqualfs	Alfisols.
Hazelair	Very fine, mixed, mesic	Aquultic Haploxerolls	Xerolls	Mollisols.
Henline	Loamy-skeletal, mixed	Entic Cryumbrepts	Umbrepts	Inceptisols.
Holcomb	Fine, montmorillonitic, mesic	Mollic Albaqualfs	Aqualfs	Alfisols.
Horeb	Fine-loamy, mixed, mesic	Typic Haplumbrepts	Umbrepts	Inceptisols.
Hullt	Fine-loamy, mixed, mesic	Typic Xerumbrepts	Umbrepts	Inceptisols.
Jory	Clayey, mixed, mesic	Xeric Haplohumults	Humults	Ultisols.
Kinney	Fine-loamy, mixed, mesic	Andic Haplumbrepts	Umbrepts	Inceptisols.
Labish	Fine, montmorillonitic, acid, mesic	Cumulic Humaquepts	Aquepts	Inceptisols.
McAlpin	Fine, mixed, mesic	Cumulic Ultic Haploxerolls	Xerolls	Mollisols.
McBee	Fine-silty, mixed, mesic	Cumulic Ultic Haploxerolls	Xerolls	Mollisols.
McCully	Fine, mixed, mesic	Typic Haplumbrepts	Umbrepts	Inceptisols.
Minniece	Fine, mixed, mesic	Typic Umbraqualfs	Aqualfs	Alfisols.
Nekia	Clayey, mixed, mesic	Xeric Haplohumults	Humults	Ultisols.
Newberg	Coarse-loamy, mixed, mesic	Fluventic Ultic Haploxerolls	Xerolls	Mollisols.
Salem	Fine-loamy, over sandy or sandy-skeletal, mixed, mesic.	Pachic Ultic Argixerolls	Xerolls	Mollisols.
Salkum	Fine, mixed, mesic	Ultic Haploxeralfs	Xeralfs	Alfisols.
Santiam	Fine, mixed, mesic	Aquultic Haploxeralfs	Xeralfs	Alfisols.
Semiahmoo				Histosols.
Sifton	Medial, over sandy or sandy-skeletal, mixed, mesic.	Umbric Vitrandepts	Andepts	Inceptisols.
Silverton	Fine, mixed, mesic	Pachic Ultic Argixerolls	Xerolls	Mollisols.
Stayton	Medial, mixed	Lithic Umbric Vitrandepts	Andepts	Inceptisols.
Steiwer	Fine-loamy, mixed, mesic	Ultic Haploxerolls	Xerolls	Mollisols.
Waldo	Fine, mixed, noncalcareous, mesic	Fluventic Haplaquolls	Aquolls	Mollisols.
Wapato	Fine-silty, mixed, noncalcareous, mesic	Fluventic Haplaquolls	Aquolls	Mollisols.
Whetstone	Coarse-loamy, mixed, ortstein	Typic Cryorthods	Orthods	Spodosols.
Willamette	Fine-silty, mixed, mesic	Pachic Ultic Argixerolls	Xerolls	Mollisols.
Witzel	Loamy-skeletal, mixed, mesic	Lithic Ultic Haploxerolls	Xerolls	Mollisols.
Woodburn	Fine-silty, mixed, mesic	Aquultic Argixerolls	Xerolls	Mollisols.

[1] Placement of some soil series in the present system of classification may change as more precise information becomes available.

New soil series must be established and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program across the country. A proposed new series has tentative status until review of the series concept at State, regional, and national levels of responsibility for soil classification results in a judgment that the new series should be established. Many of the soil series described in this publication have been established earlier. Twenty-four of the soil series described had tentative status when the survey was sent to the printer. They are the Abiqua, Bashaw, Chehalem, Chehulpum, Cloquato, Cumley, Hazelair, Henline, Horeb, Hullt, Jory, Kinney, Labish, McAlpin, McBee, McCully, Minniece, Nekia, Santiam, Silverton, Stayton, Steiwer, Whetstone, and Witzel.

Descriptions of soil series by subgroups

A discussion of the soil series in the Marion County Area, by subgroups, is given in the following paragraphs. A representative profile for each series is described in the section "Descriptions of the Soils."

Typic Pelloxererts.—The Bashaw soils are in this subgroup. They are nearly level, poorly drained and very poorly drained, clayey soils that have formed on flood plains and in drainage channels of alluvial terraces. Cracks tend to form in these soils during dry weather in summer, and they close when these soils become wet during fall rains. These soils are dark colored and are prominently mottled. In the uppermost 40 inches, they contain slickensides.

Cumulic Humaquepts.—The Labish soils are in this subgroup. These are poorly drained, clayey soils that formed on lake bottoms. They have a dark color of low chroma, and a base saturation of less than 50 percent to a depth of 4 feet. The content of organic matter is high.

Umbric Vitrandepts.—The Sifton soils, which are excessively drained, nearly level soils on alluvial terraces, are in this subgroup. These soils have an A and a B2 horizon of gravelly loam. These horizons have low bulk density, and they consist predominantly of amorphous material. The A horizon is black and has less than 50 percent base saturation.

Lithic Umbric Vitrandepts.—The Stayton soils are in this subgroup. They are well-drained, medium-textured soils that have formed on foot slopes and in drainageways of foothills. These soils are underlain by basalt at a depth of 15 to 20 inches. They have low bulk density and consist predominantly of amorphous material. Typically, the A horizon is black and has less than 50 percent base saturation.

Entic Cryumbrepts.—The Henline soils are in this subgroup. These soils are well drained, very stony, and moderately coarse textured, and they have formed in colluvium from basalt or agglomerate on mountainous uplands. Typically, the A horizon is very dark brown and has less than 50 percent base saturation. It is underlain by a C horizon that is 60 to 70 percent coarse fragments. The average annual soil temperature is about 45° F.

Typic Haplumbrepts.—The Horeb and McCully soils are in this subgroup. These soils are well drained or moderately well drained. They have formed in till or colluvium on the foot slopes of mountains. Typically, the Horeb soils have an A1 horizon of very dark brown or very dark grayish-brown loam about 14 inches thick. Base saturation is less than 50 percent in the A horizon. The B2 horizon is dark-brown or dark yellowish-brown gravelly loam about 17 inches thick. The profile of the McCully soils is similar to that of the Horeb soils, except that the A1 horizon is dark reddish-brown clay loam and the B2 horizon is dark reddish-brown clay. Laboratory data for a typical McCully profile are given in table 9.

Andic Haplumbrepts.—The Kinney soils, on the foot slopes of mountains, are in this subgroup. These are well-drained, moderately fine textured soils that formed in glacial till. They have a dark-colored A and upper B horizon, and these horizons have low bulk density and very low base saturation. The combined thickness of these horizons is about 15 inches. Laboratory data for a typical Kinney profile are given in table 9.

Typic Xerumbrepts.—The Hullt soils, on the foot slopes of mountains, are in this subgroup. These soils are well drained and are moderately fine textured. They have formed in colluvium from sandstone. Typically, the A horizon of these soils is very dark brown or dark brown clay loam about 15 inches thick, and it has base saturation of less than 50 percent. These soils are dry for more than 60 consecutive days following the summer solstice.

Typic Cryorthods.—The Whetstone soils are in this subgroup. They are well-drained, medium-textured soils that have formed on mountainous uplands in till and colluvium from basic igneous rock. The average annual soil temperature is about 41° F. Typically, the Whetstone soils have a thick O horizon overlying a thin A2 horizon that is dark gray when moist. The B2ir horizon is dark reddish brown in the upper part and has thin bands of iron accumulation and many, firm, dark reddish-brown nodules in the lower part.

Typic Haplohumults.—The Cumley soils are in this subgroup. These soils are moderately well drained and have formed in till and colluvium on the foot slopes of mountains. Cumley soils have a clay B2t horizon that has less than 35 percent base saturation. The upper part of the B2t horizon also has a high content of organic matter.

Xeric Haplohumults.—Jory and Nekia soils are in this subgroup. These soils are well drained and have formed in colluvium from tuff and basalt. They occur on foothills. Their content of organic matter is high to a depth of about 40 inches.

The Jory soils are typical of soils in this subgroup. They have a thick A1 horizon of reddish-brown silty clay loam, underlain by a B2t horizon of dark reddish-brown silty clay. Basalt is at a depth of more than 5 feet. Base saturation of the A1 and B2t horizons is less than 35 percent. The Jory soils are generally dry for more than 60 consecutive days following the summer solstice. Laboratory data for a typical Jory soil are given in table 9.

Nekia soils are essentially like the Jory soils, except that they are underlain by bedrock at some depth between 20 and 40 inches. Bedrock is generally at a depth of about 36 inches.

Argiaquic Xeric Argiabolls.—The Amity soils are in this subgroup. They are somewhat poorly drained and have formed in mixed alluvium on broad valley terraces. Typically, the Amity soils have a dark-colored A1 horizon; a mottled, dark-gray A2 horizon; and a mottled, grayish-brown silty clay loam B2t horizon. They are dry for more than 60 consecutive days following the summer solstice.

Typic Argiaquolls.—The Clackamas soils are in this subgroup. These soils are somewhat poorly drained and have formed in gravelly alluvium on terraces. Typically, the Clackamas soils have a very dark grayish-brown A horizon and a mottled, very dark gray gravelly clay loam B2t horizon.

Abruptic Argiaquolls.—The Courtney soils are in this subgroup. They are poorly drained, clayey soils that have formed in gravelly alluvium in depressions and drainageways of terraces. Typically, the A horizon is black or very dark gray and contains distinct mottles. An abrupt boundary separates the A horizon from a mottled, dark-gray gravelly clay B2t horizon.

Cumulic Haplaquolls.—The Chehalem soils are in this subgroup. They are somewhat poorly drained, fine-textured soils that have formed in alluvium on alluvial fans. Typically, the Chehalem soils have a very dark brown A horizon; a mottled, very dark grayish-brown upper B2 horizon, and a mottled, dark grayish-brown lower B2 horizon. The content of organic matter is high, but in the uppermost 50 inches, it decreases irregularly with depth.

Fluventic Haplaquolls.—The Waldo and Wapato soils are in this subgroup. They are poorly drained and have formed in alluvium on flood plains.

The Waldo soils are representative of soils in this subgroup. Typically, they have a very dark grayish-brown A horizon that has prominent mottles in the lower part. Their B2 horizon is dark-gray, mottled clay.

The Wapato soils are similar to the Waldo soils, except that they have silty clay loam texture throughout.

Aquultic Argixerolls.—Woodburn soils on broad valley terraces are in this subgroup. These soils are moderately well drained and are moderately fine textured. They have formed in silty alluvium of mixed origin. Like all other Xerolls in this survey area, the Woodburn soils are usually moist, but they are dry for more than 60 consecutive days following the summer solstice. These soils have a very dark brown or dark brown A horizon; a dark yellowish-brown upper B2t horizon; and a mottled, dark-brown lower B2t horizon. The base saturation of the A and B2t horizons is less than 75 percent. Laboratory data for a typical Woodburn profile are given in table 9.

Pachic Ultic Argixerolls.—The Salem, Silverton, and Willamette soils are in this subgroup. These soils are well drained and have formed in silty material on terraces.

The Willamette soils are representative of soils of this subgroup. Typically, they are dark colored, have a high content of organic matter to a depth of 24 inches, and have less than 75 percent base saturation in the uppermost 30 inches. The A horizon is very dark grayish-brown silt loam, and the B2t horizon is dark-brown silty clay loam.

The Silverton and Salem soils are similar to the Willamette, except that the upper B2t horizon of the Silverton soils is silty clay loam, the lower B2t horizon is silty clay, and depth to weathered basalt is 20 to 40 inches. The Salem soils have a gravelly B2t horizon that is underlain by a C horizon of very gravelly sand.

Aquultic Hapoxerolls.—The Hazelair soils are in this subgroup. These soils are moderately well drained and have formed over sandstone or shale. They occur on foot slopes, adjacent to the valley floor. Typically, the Hazelair soils have a very dark brown A horizon and a thin, very dark grayish-brown B2 horizon. Light brownish-gray mottles are at a depth between 18 and 28 inches.

Cumulic Ultic Haploxerolls.—The Abiqua, Chehalis, Cloquato, McAlpin, and McBee soils, all formed in alluvium, are in this subgroup. The McAlpin soils are moderately well drained and somewhat poorly drained, and the McBee soils are moderately well drained. All of the other soils are well drained.

The Cloquato soils are representative of soils in this subgroup. Typically, they have an A and a B horizon of dark-brown silt loam. The content of organic matter is high, and it decreases irregularly with depth. Base saturation is less than 75 percent in the uppermost 30 inches of the profile.

The Chehalis soils have a texture of silty clay loam throughout. The Abiqua and McAlpin soils have a B2 horizon of dark reddish-brown silty clay, but the B2 horizon of the McAlpin soils is mottled. The McBee soils have a dominant texture of silty clay loam throughout, and they have a mottled B2 horizon.

Entic Haploxerolls.—The Chehulpum soils are in this subgroup. These soils are on foothills. They are well drained and are shallow over bedrock. Sandstone bedrock is at a depth of only 10 to 12 inches beneath an A horizon of very dark brown silt loam.

Fluventic Haploxerolls.—The Camas soils are in this subgroup. They are excessively drained soils that formed in alluvium on flood plains, where they are subject to flooding. The Camas soils have an A horizon of gravelly sandy loam, about 9 inches thick, and a C horizon of very gravelly sand. The content of organic matter decreases irregularly with depth.

Fluventic Ultic Haploxerolls.—The Newberg soils, which are somewhat excessively drained, are in this subgroup. These soils have formed in alluvium. They are on flood plains and are subject to flooding. The Newberg soils have an A horizon of very dark grayish-brown fine sandy loam about 10 inches thick. The A horizon has less than 75 percent base saturation. The C horizon is at some depth between 10 and 60 inches, and it is dark yellowish-brown sandy loam. The content of organic matter decreases irregularly with depth.

Lithic Ultic Haploxerolls.—The Witzel soils are in this subgroup. These soils are well drained. They have formed in colluvium, dominantly from basic igneous rock, and they occur on foothills. The Witzel soils have an A horizon of dark-brown very stony silt loam, and a B2 horizon of dark-brown and dark reddish-brown very stony silty clay loam. Basalt bedrock is at a depth of 14 to 20 inches. Base saturation of these soils is less than 75 percent.

Ultic Haploxerolls.—The Steiwer soils are in this subgroup. These soils are well drained and have formed in alluvium and colluvium of sedimentary origin. They are on low foothills and the foot slopes of mountains. Typically, the Steiwer soils have an A1 horizon of very dark brown or very dark grayish-brown silt loam, and a B2 horizon of dark yellowish-brown silty clay loam. Sandstone bedrock is at a depth of about 32 inches. The A and B horizons have a base saturation of less than 75 percent. Laboratory data for a typical Steiwer soil are given in table 9.

Typic Albaqualfs.—The Dayton soils are in this subgroup. They are poorly drained and have formed in alluvium. These soils are on broad valley terraces. They occur in shallow depressions and in drainageways. In a typical profile, the Dayton soils have an Ap horizon of very dark grayish-brown silt loam that has less than 50 percent base saturation. They have an A2 horizon of dark-gray silt loam that contains a few black and red concretions and common mottles. An abrupt boundary separates the A2 horizon from a IIB2t horizon of dark-gray and grayish-brown clay.

Mollic Albaqualfs.—The Holcomb soils are in this subgroup. These soils are somewhat poorly drained and are nearly level. They have formed in alluvium on terraces. Typically, the Holcomb soils have an Ap horizon of very dark brown silt loam and an A1 horizon of very dark grayish-brown silt loam. Base saturation of these horizons is less than 50 percent. The A2 horizon is dark-brown silty clay loam, and an abrupt boundary separates that horizon from a IIB2t horizon of dark grayish-brown clay.

Typic Ochraqualfs.—The Concord soils are in this subgroup. These poorly drained, clayey soils have formed in alluvium. They are in concave depressions and drainageways on broad valley terraces. Typically, the Concord soils have a silt loam Ap horizon that is very dark grayish brown when moist and light brownish gray when dry. Their A2 horizon is mottled dark-gray silt loam that grades to a IIB2t horizon of grayish-brown silty clay.

Typic Umbraqualfs.—The Minniece soils are in this subgroup. These soils are somewhat poorly drained or poorly drained. They are in seepage areas and in drainage channels and have formed in colluvium and alluvium. Typically, the Minniece soils have an A1 horizon of very dark grayish-brown silty clay loam that grades to a IIB2tg horizon of dark grayish-brown and gray silty clay and clay.

Aquultic Haploxeralfs.—The Santiam soils are in this subgroup. These soils are moderately well drained, and they occur on high terrace remnants near the foothills. Like the Xerolls, these soils are dry for more than 60 consecutive days within the 3-month period following the summer solstice. Typically, the Santiam soils have an Ap horizon of dark-brown silt loam; an A3 horizon of mottled, dark-brown silt loam; and a B2t horizon of mottled, dark yellowish-brown silty clay loam. In some places in the uppermost 30 inches of the profile, base saturation is less than 75 percent.

Ultic Haploxeralfs.—The Salkum soils are in this subgroup. These soils are well drained, and they have formed in gravelly alluvium on truncated high terraces. Typically, the Salkum soils have an Ap and an A1 horizon of very dark brown silty clay loam. The A1 horizon grades to a B2t horizon of dark-brown silty clay.

Histosols.—Organic soils of the Semiahmoo series are Histosols. The surface layer of these soils is black muck about 9 inches thick. The surface layer is underlain by a layer of very dark brown peaty muck that extends to a depth of about 30 inches. The material between depths of 30 and 60 inches is peat.

Laboratory Data

Table 9 shows the results of physical and chemical analyses of five soils mapped in the survey area. All the samples analyzed were taken from carefully selected pits. The soil material was rolled, crushed, and sieved by hand to remove fragments of rock more than 2 millimeters in diameter. Laboratory analyses were made on particles of soil material less than 2 millimeters in diameter. Results are reported on an oven-dry soil basis.

Particle-size analysis was made by using the pipette method (*5*, *6*). Reaction was measured with a glass electrode, using the soil-water and soil-salt ratios indicated (*9*). Organic carbon was determined by wet combustion in a modification of the Walkley-Black method (*9*). Total nitrogen was determined by the Association of Official Agricultural Chemists (AOAC) Kjeldahl method (*2*). Extractable cations were determined by methods described in USDA Circular 757 (*9*). Sodium and potassium in the saturation extract were analyzed through the use of a Beckman flame spectrophotometer (*3*). Calcium and magnesium were determined by methods described in USDA Handbook No. 60 (*14*). Free iron oxide was determined by titration of the extract that was obtained when the soil was treated with sodium dithonite (*4*).

Bulk density was determined with a 4.7 by 3.5 centimeter tube and an Uhland-type core sampler (*12*). Moisture retention at a tension of 15 atmospheres was determined by testing fragmented samples in a pressure membrane apparatus (*14*).

General Nature of the Area

This section describes the climate of the Marion County Area, discusses the settlement and development of this area, and gives facts about farming. Unless otherwise stated, statistics used are from records of the U.S. Bureau of the Census.

Climate [5]

Marion County has a modified marine climate, which varies considerably because of increases in elevation between the valley of the Willamette River and the summit of the Cascade Mountains. Three geographic features—the Pacific Ocean, the Coast Range, and the Cascade Mountains—mainly influence the climate within the survey area. The Pacific Ocean, about 50 miles west of Marion County, determines the dominant characteristics of the weather pattern; the Coast Range modifies the temperature of air masses before they reach Marion County; and the Cascade Mountains are responsible for the many variations of climate within the county.

[5] GILBERT L. STERNES, climatologist for the State of Oregon, assisted in preparing this subsection.

Air masses generally move from west to east, and they have traveled over water for several days before reaching Marion County. As a rule, such air is saturated or nearly saturated with moisture, and its temperature is near that of the ocean.

The Coast Range extends the full north-south length of the State of Oregon. It lies between the Pacific Ocean and the Willamette River, which is the western boundary of Marion County and of the survey area. The Coast Range begins near the coast, and its crest is near the Willamette River. Elevations of the Coast Range at the crest are 1,500 to 2,500 feet.

The Coast Range acts as a buffer to protect the Willamette Valley and other inland valleys from severe storms that originate in the ocean and move onto the Oregon coast during the period from mid-October to late in March or early in April. Incoming air flowing from the ocean is cooled several degrees as it rises to cross the Coast Range. As this cooling takes place, the air becomes oversaturated and sheds its moisture as rain or snow. Most of this falls on the west slope of the Coast Range, which receives more precipitation than most areas in this part of the United States. Air that has lost much of its moisture over the Coast Range has considerably less potential than it had for producing rain or snow as it moves eastward over land. Rising and cooling air crossing the Coast Range produces many clouds that drift many miles inland. As a consequence, sunshine in the Willamette Valley late in fall and in winter is only about 20 to 30 percent of the maximum possible amount. Humidity is lower and fog is less frequent on the eastern side of the Coast Range than along the coast.

Land masses modify the temperature of the air before the air reaches Marion County. This occurs because land masses tend to heat more rapidly than the ocean in summer, and they tend to cool more rapidly than the ocean in winter.

The Cascade Mountains are another important feature responsible for variations of climate in Marion County. Although elevations in the western part of the county are slightly less than 100 feet, the crest of the Cascade Mountains has elevations of 5,000 to 6,000 feet. As elevation increases, the average air temperature is lowered and the growing season is shortened. The cooling effect of higher elevations increases the total amount of precipitation that falls either as rain or snow. The Cascade Mountains prevent the great masses of continental air from reaching the valleys and foothills of the western slopes. As a result, extreme temperatures that occur in winter and summer in areas only 100 to 200 miles east of Marion County are rarely experienced in the Willamette Valley.

Nearly all farming in the survey area, except tree farming, is done at elevations of approximately 100 to 2,500 feet. For this reason, most of this soil survey is about soils that occur at elevations of 100 to 2,500 feet. Facts given about climate are also mainly for this range in elevation. To provide a realistic picture of climate, the soil survey area has been divided into three zones, largely according

TABLE 9.—*Soil characterization data for selected*

[Analyses made at the Soil Survey Laboratory, Soil Conservation

Soil name and sample number	Depth from surface	Horizon	Particle-size distribution									Moisture held at tensions of—	
			Very coarse sand (2–1 mm.)	Coarse sand (1–0.5 mm.)	Medium sand (0.5–0.25 mm.)	Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (less than 0.002 mm.)	Particles		⅓ atmosphere	15 atmospheres
										0.20–0.02 mm.	0.02–0.002 mm.		
	In.		*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Jory silty clay: Profile No. 1, S55 Oreg.–24-6 (1–8).	0–4	Apl	1. 6	3. 3	2. 8	5. 2	4. 4	49. 4	33. 3	22. 3	34. 5	33. 3	17. 1
	4–8	Ap2	1. 9	3. 0	2. 7	5. 2	4. 7	48. 6	33. 9	22. 1	34. 4	28. 9	17. 0
	8–15	A3	1. 3	2. 6	2. 6	4. 9	4. 2	48. 0	36. 4	21. 1	34. 1	27. 0	17. 2
	15–20	Blt	. 7	2. 2	2. 5	4. 8	4. 0	43. 9	41. 9	20. 5	30. 3	25. 2	17. 6
	20–28	B21t	. 9	2. 2	2. 3	4. 5	3. 9	42. 3	43. 9	19. 7	29. 2	25. 0	18. 3
	28–36	B22t	. 9	2. 1	2. 0	4. 2	3. 8	41. 9	45. 1	18. 5	29. 7	25. 9	18. 9
	36–50	B23t	. 9	2. 0	2. 0	4. 1	3. 7	39. 7	47. 6	18. 3	27. 6	26. 9	19. 9
	50–63	B24t	2. 4	1. 8	1. 5	3. 3	3. 5	34. 6	52. 6	16. 1	24. 1	27. 6	21. 9
Kinney silt loam: Profile No. 2, 60 Oreg.–24–1 (1–8).	2–0	01/02											
	0–5	A11	13. 5	14. 5	6. 2	8. 4	4. 7						9. 6
	5–9	A12	5. 3	11. 4	5. 0	8. 7	4. 9						26. 7
	9–18	B1	3. 6	11. 4	5. 9	9. 8	4. 8						25. 4
	18–29	B21	5. 0	17. 8	7. 3	11. 5	5. 4						27. 1
	29–37	B22	1. 7	15. 1	9. 5	15. 1	7. 1						28. 0
	37–47	B3	1. 0	15. 4	10. 3	15. 4	7. 3						28. 9
	47–70	IIR											
McCully clay loam: Profile No. 3, 60 Oreg.–24–3 (1–9).	1–0	01/02											
	0–7	A1											28. 6
	7–12	A3											26. 6
	12–22	B1											24. 8
	22–40	B21											23. 5
	40–48	B22											23. 7
	48–58	B3											24. 4
	58–82	C1/IIR											21. 8
	82–108	C2/IIR											19. 5
Steiwer silty clay loam: Profile No. 4, S62 Oreg.–36-7 (1–5).	0–6	Ap	. 5	1. 5	2. 7	11. 8	10. 2						18. 8
	6–10	B1	. 3	1. 2	2. 6	11. 8	11. 2	38. 9	24. 0	29. 3	27. 3		18. 7
	10–19	B2	. 2	1. 3	2. 6	11. 7	10. 3	40. 7	33. 2	30. 2	27. 3		18. 9
	19–27	B3	. 2	1. 2	2. 5	11. 3	12. 4	39. 2	33. 2	30. 3	27. 7		18. 8
	27–40	IIR											
Woodburn silt loam: Profile No. 5, S62 Oreg.–24-4 (1–7).	0–9	Ap										20. 9	9. 3
	9–17	A12										22. 9	10. 0
	17–25	B21t										27. 4	11. 3
	25–32	B22t										26. 0	13. 0
	32–39	B31t										28. 1	13. 2
	39–54	B32t										26. 8	12. 5
	54–68	C1										30. 5	12. 6

[1] For the Jory soil, cation-exchange capacity was determined by the ammonium acetate method.
[2] For the Woodburn soil, bulk density values were determined on oven-dry basis.

soils in the Marion County Area, Oregon

Service, Riverside, Calif. Dashes indicate data were not available]

Bulk density	pH: In water 1:1	pH: In potassium chloride 1:1	Organic matter: Organic carbon	Organic matter: Nitrogen	Organic matter: Carbon-nitrogen ratio	Manganese oxide	Extractable iron	Cation-exchange capacity (NaAc)	Extractable cations (milliequivalents per 100 gm. of soil): Calcium	Magnesium	Hydrogen	Sodium	Potassium	Base saturation
Gm./cc.			Pct.	Pct.		Pct.	Pct.	Pct.						Pct.
	5.9	--------	4.04	0.263	15.4	--------	7.4	[1] 23.1	11.3	2.1	17.7	0.1	1.1	45
--------	5.5	--------	2.66	.177	15.0	--------	7.9	[1] 21.4	9.8	1.8	18.8	.1	.3	39
--------	5.5	--------	1.90	.131	14.5	--------	8.0	[1] 20.5	8.2	2.2	17.5	.1	.2	38
--------	5.2	--------	.82	.072	11.4	--------	7.8	[1] 17.8	4.8	2.9	13.8	.1	.2	37
--------	5.0	--------	.58	.055	10.5	--------	7.9	[1] 15.7	3.6	3.0	13.8	.1	.1	33
--------	4.9	--------	.48	.051	9.4	--------	8.0	[1] 15.4	2.9	3.8	13.4	.1	.1	34
--------	4.9	--------	.40	.048	8.3	--------	8.2	[1] 15.2	2.9	3.6	12.7	.1	.1	34
--------	4.9	--------	.37	.059	6.3	--------	8.9	[1] 14.7	3.0	3.3	13.5	.1	.1	32
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
--------	5.1	4.2	6.88	.339	20.3	0.26	2.5	54.9	3.7	2.2	35.5	.2	.7	16
--------	5.2	4.2	4.33	.229	18.9	.22	2.7	37.3	.7	.7	32.6	.2	.3	6
--------	5.3	4.0	2.13	.131	16.2	.14	2.7	32.8	.6	.5	28.2	.2	.1	5
--------	5.2	3.9	.53	.040	13.3	.03	2.6	33.1	.7	.9	28.7	.3	<.1	6
--------	5.1	3.7	.22	.018	12.2	.00	2.2	32.2	.5	1.3	29.3	.3	<.1	7
--------	5.0	3.8	.38	.021	18.1	<.01	2.5	36.2	.7	1.2	32.3	.3	.1	7
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
--------	5.6	4.4	6.95	.383	18.1	.14	4.7	51.7	3.5	2.0	34.8	.2	.8	16
--------	5.5	4.2	3.63	.220	16.5	.11	5.0	32.2	.9	.8	27.4	.2	.2	7
--------	5.4	4.0	1.70	.103	16.5	.06	5.3	26.3	.7	.7	22.9	.2	.1	7
--------	5.3	3.9	.39	.030	13.0	.03	6.0	20.9	.7	.6	18.1	.2	<.1	8
--------	5.3	4.0	.20	--------	--------	.03	5.7	19.5	.8	.4	19.1	.2	<.1	7
--------	5.6	3.8	.23	--------	--------	.02	6.0	20.1	.5	.3	18.3	.2	<.1	5
--------	5.5	3.9	.07	--------	--------	.03	6.4	18.9	.6	.3	18.1	.2	<.1	6
--------	5.6	3.7	.11	--------	--------	.09	5.8	21.6	.5	.3	19.3	.2	.1	5
--------	5.4	4.2	3.00	.241	12	--------	3.4	42.8	15.2	8.1	18.3	.2	1.0	57
--------	5.3	4.1	2.25	.184	12	--------	3.4	42.1	15.3	8.3	17.4	.3	.8	59
--------	5.3	4.0	1.73	.154	11	--------	3.9	41.6	14.7	8.5	17.5	.3	.6	58
--------	5.2	3.9	1.27	.126	10	--------	2.9	41.0	14.1	7.8	18.4	.3	.4	55
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
[2] 1.48	5.9	--------	1.86	.109	17	--------	--------	22.6	7.7	1.2	13.1	.1	.5	42
[2] 1.58	6.2	--------	.56	.049	11	--------	--------	19.0	6.7	1.6	10.0	.1	.6	47
[2] 1.57	6.0	--------	.34	--------	--------	--------	--------	19.6	8.5	2.7	7.6	.2	.6	61
[2] 1.56	5.8	--------	.25	--------	--------	--------	--------	24.0	11.3	3.7	8.0	.2	.8	67
[2] 1.53	5.7	--------	.14	--------	--------	--------	--------	24.7	12.1	4.1	7.5	.3	.7	70
[2] 1.55	5.9	--------	.09	--------	--------	--------	--------	23.8	13.2	4.6	5.1	.3	.6	78
[2] 1.52	5.9	--------	.07	--------	--------	--------	--------	24.0	13.6	5.1	4.5	.3	.5	81

to differences in elevation. These zones are (1) the floor of the Willamette Valley, where elevations are between about 100 and 500 feet; (2) the low foothills of the Cascade Mountains, where elevations are between 500 and 1,500 feet; and (3) the foot slopes of the Cascade Mountains, where elevations are between 1,500 and 3,500 feet. Table 10 gives characteristics of the climate in each of these zones. Table 11 gives for each zone the probability of the occurrence of temperatures of 32 degrees, or colder, in spring and fall for specified dates. The averages shown

TABLE 10.—*Temperature and precipitation*

Month	Temperature				Precipitation		
	Average daily maximum	Average daily minimum	2 years in 10 will have at least 4 days with— Maximum temperature equal to or higher than—	2 years in 10 will have at least 4 days with— Minimum temperature equal to or lower than—	Average monthly precipitation	1 year in 10 will have— Less than—	1 year in 10 will have— More than—
	°F.	°F.	°F.	°F.	In.	In.	In.
FLOOR OF THE							
January	46	33	56	20	6. 5	3. 0	11. 5
February	50	35	60	23	5. 2	2. 3	8. 2
March	56	37	67	29	4. 6	2. 2	7. 2
April	63	40	77	33	2. 3	. 7	3. 9
May	69	45	84	38	2. 1	. 5	4. 1
June	74	50	89	43	1. 5	. 3	3. 3
July	82	52	96	45	. 4	0	. 7
August	82	52	94	45	. 5	(2)	1. 3
September	77	48	91	39	1. 4	. 2	2. 8
October	65	43	78	34	4. 0	1. 2	7. 7
November	53	38	62	27	5. 8	1. 5	10. 9
December	48	36	57	24	7. 1	3. 6	10. 9
Year	64	42	[3] 100	[4] 16	41. 3	30. 5	51. 0
LOW FOOTHILLS OF THE							
January	43	30	52	18	10. 4	4. 7	17. 3
February	46	32	56	21	8. 4	4. 5	13. 3
March	52	33	64	26	8. 7	4. 6	13. 0
April	60	37	74	30	5. 4	2. 4	8. 7
May	66	41	81	34	4. 4	1. 9	7. 9
June	70	46	84	39	3. 2	1. 5	5. 0
July	79	48	92	41	. 7	. 2	1. 5
August	78	47	91	40	1. 0	. 2	2. 5
September	74	44	89	36	2. 8	. 4	5. 7
October	62	40	76	32	7. 1	2. 8	12. 5
November	50	35	59	25	10. 1	3. 0	19. 0
December	45	33	53	23	11. 3	5. 1	18. 7
Year	60	39	[3] 98	[4] 12	72. 5	58. 4	91. 1
FOOT SLOPES OF THE							
January	42	29	55	14	11. 1	5. 2	17. 9
February	45	31	58	19	9. 1	4. 5	15. 2
March	49	32	66	24	8. 6	4. 5	13. 1
April	56	35	73	29	5. 4	2. 6	8. 9
May	63	40	80	32	4. 3	1. 7	7. 4
June	68	45	84	37	3. 1	. 8	6. 4
July	77	48	90	40	. 7	. 2	1. 4
August	76	47	89	40	1. 1	. 2	2. 5
September	70	45	87	36	2. 7	. 7	5. 6
October	61	40	77	30	7. 4	2. 1	15. 1
November	51	34	65	25	10. 7	3. 8	20. 7
December	44	32	55	20	12. 2	4. 8	20. 4
Year	59	38	[3] 96	[4] 11	77. 4	58. 5	96. 9

[1] Less than one-half day.
[2] Trace.

in these tables are based on averages of figures recorded at several weather bureau stations in or adjacent to Marion County.

Precipitation.—During the period November through March, more than 70 percent of the annual precipitation in Marion County falls as rain. June, July, and August are dry. Less than 7 percent of the total annual precipitation falls during these 3 months. Rainfall of 0.01 inch or more occurs on an average of 150 to 175 days each year, with the greater amount falling at the higher elevations. In

in the Marion County Area

WILLAMETTE VALLEY

Precipitation—Continued									
2 years in 10 will have—		3 years in 10 will have—		4 years in 10 will have—		Average snowfall	Maximum depth of snow on ground	Maximum number of days with snow cover	Average depth of snow on days with snow cover
Less than—	More than—	Less than—	More than—	Less than—	More than—				
In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*		*In.*
4.0	9.6	4.7	8.1	4.7	6.8	4	14	2	4
3.2	6.8	3.7	6.0	4.5	5.6	1	15	1	3
2.9	5.9	3.4	5.4	4.2	5.2	1	3	[1]	3
1.1	3.4	1.6	2.9	1.8	2.7	[2]	[2]	0	0
.9	3.4	1.1	3.0	1.4	2.9	[2]	[2]	0	
.4	2.6	.6	1.7	.6	1.5	0	0	0	
[2]	.5	.2	.5	.3	.4	0	0	0	
.1	.8	.1	.5	.2	.5	0	0	0	
.5	2.1	.7	1.7	.9	1.8	0	[2]	0	
1.9	5.8	2.4	4.7	2.9	4.3	[2]	4	[1]	
2.4	8.7	3.3	7.1	4.6	6.6	[2]	4	[1]	
4.6	9.5	5.2	8.7	5.7	8.2	[2]	5	[1]	
35.1	47.2	37.6	44.5	39.4	42.5	[2]	15	3	

CASCADE MOUNTAINS

6.3	14.6	7.4	12.5	8.5	11.0	11	40	8	7
5.6	11.3	6.5	10.0	7.3	9.0	5	50	7	10
5.6	11.2	6.7	10.0	7.3	9.1	4	35	3	5
3.2	7.2	3.8	8.3	4.3	5.5	[2]	0	[1]	2
2.5	6.5	3.1	5.5	3.6	4.7	0	0	0	0
2.0	4.2	2.2	3.6	2.6	3.2	0	0	0	0
.3	1.1	.3	.9	.5	.7	0	0	0	0
.3	1.7	.4	1.3	.5	1.1	0	0	0	0
.9	4.3	1.3	3.5	1.8	3.0	0	0	0	0
3.7	10.1	4.6	8.5	5.5	7.3	[2]	0	0	0
4.4	14.2	5.7	11.9	7.1	10.3	1	4	1	2
6.6	15.2	7.9	13.7	9.0	11.5	4	13	2	3
63.0	83.7	66.7	79.4	69.8	76.3	25	50	21	7

CASCADE MOUNTAINS

7.0	14.9	8.1	12.9	9.2	11.7	26	61	14	13
5.8	12.6	6.6	11.0	7.6	9.6	15	56	14	13
5.6	11.1	6.4	9.9	7.2	8.9	13	46	10	3
3.3	7.4	3.9	6.5	4.4	5.7	5	9	2	3
2.4	6.1	3.0	5.2	3.4	4.5	[2]	2	[1]	1
1.2	4.9	1.5	3.9	2.1	3.2	0	0	0	0
.3	1.1	.3	.9	.5	.7	0	0	0	0
.3	1.6	.5	1.4	.6	1.1	0	0	0	0
1.0	4.1	1.3	3.3	2.8	2.6	0	[2]	0	0
3.0	11.5	4.1	9.0	4.9	7.4	[2]	4	[1]	2
5.4	16.3	6.7	13.3	8.2	11.4	3	10	2	3
6.5	17.3	8.1	15.1	9.4	12.6	12	31	7	5
64.2	89.5	68.7	83.2	72.4	79.9	74	61	49	10

[3] Average annual highest maximum temperature.
[4] Average annual lowest minimum temperature.

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TABLE 11.—*Probability of given temperatures after specified dates in spring and before specified dates in fall*

Probability	Dates for given probability and temperature			
	24° or lower	28° or lower	32° or lower	36° or lower
FLOOR OF THE WILLAMETTE VALLEY				
Spring:				
1 year in 10, later than	February 27	April 5	May 8	May 26
2 years in 10, later than	February 17	March 25	April 28	May 21
5 years in 10, later than	January 28	March 3	April 9	May 1
Fall:				
1 year in 10, earlier than	November 13	October 28	October 15	September 20
2 years in 10, earlier than	November 22	November 5	October 21	September 28
5 years in 10, earlier than	December 9	November 21	November 2	October 13
LOW FOOTHILLS OF THE CASCADE MOUNTAINS				
Spring:				
1 year in 10, later than	March 24	April 18	May 17	(1)
2 years in 10, later than	March 10	April 8	May 8	(1)
5 years in 10, later than	February 14	March 18	April 20	(1)
Fall:				
1 year in 10, earlier than	November 10	October 25	October 3	(1)
2 years in 10, earlier than	November 18	October 31	October 9	(1)
5 years in 10, earlier than	December 4	November 14	October 21	(1)
FOOT SLOPES OF THE CASCADE MOUNTAINS				
Spring:				
1 year in 10, later than	April 11	May 13	June 12	(1)
2 years in 10, later than	April 1	May 4	June 3	(1)
5 years in 10, later than	March 14	April 16	May 18	(1)
Fall:				
1 year in 10, earlier than	November 1	October 14	September 14	(1)
2 years in 10, earlier than	November 6	October 21	September 21	(1)
5 years in 10, earlier than	November 19	November 3	October 5	(1)

[1] Date not calculated because occurrence of this temperature is rare.

winter, precipitation is generally the result of frequent storms that move in from the Pacific Ocean. In summer, most of the precipitation falls during occasional thunderstorms. As late as mid-June, the chance that a shower will occur on any particular day is about 1 in 3. As a rule, showers are light early in summer, but they bring enough rainfall to interfere with haying and with the harvesting of grass seed. Occasionally, these showers cause severe cracking of sweet cherries that are beginning to ripen.

In the principal areas used for farming, nearly all of the precipitation in winter is in the form of rain. Only in the highest of the three zones, the foot slopes of the Cascade Mountains, is any significant amount of snow expected each year. On rare occasions snow accumulates to depths of 8 to 15 inches on the floor of the Willamette Valley. Generally, the accumulation does not exceed 3 to 4 inches, and it melts within a few hours. Even the deepest accumulations of snow at these low elevations seldom lie longer than 4 to 5 days.

Severe winter storms that originate on the eastern slopes of the Coast Range and on the western slopes of the Cascade Mountains have caused serious flooding along the Willamette River and its major tributaries. During the past few years, construction of a system of dams has greatly lessened the risk of flooding, and these dams have also produced electrical power and have made water available for irrigation. Some areas of bottom lands are still flooded, to some extent, each year. For the most part, however, the only areas that are flooded are those in pasture, and little erosion is caused by the floodwaters. Nevertheless, constructing farm buildings in these low-lying areas is still hazardous.

Temperature.—Extremes in temperature are rare in this county. On an average of only about 12 to 16 days a year do temperatures in the Willamette Valley rise above 90° F., according to the U.S. Weather Bureau. At elevations of 2,500 feet, this average decreases to 2 to 4 days. Probably in no place in the county do temperatures of more than 100° F. occur oftener than every other year. Some stations near the highest parts of the foot slopes of the Cascade Mountains have no record of temperatures ever reaching as high as 100°.

The number of days when the minimum temperature is below freezing ranges from about 60 a year, on the floor of the Willamette Valley, to 90, in areas where the elevation is nearly 2,500 feet. In only about 1 year in 30 or 40 is a temperature of zero or below likely to be experienced in any part of the county.

Wind.—The growing use of airplanes for applying fertilizer and insecticides has led to increased interest in velocity of the wind. Windspeed is also of interest because strong winds can damage fruit trees and ripening fruit, and they can cause lodging of uncut hay and grain.

Prevailing winds generally blow from the north or northwest in summer and from the south the rest of the year. At times throughout the year, strong winds that are very dry blow from the east. These winds are caused by masses of continental air that intrude from areas east of the Cascade Mountains. They rapidly deplete soil moisture, dry out plants, and often cause a critical danger of fire in wooded areas.

Windspeed, as recorded by the weather bureau station at the Salem Airport, is generally representative of that along the floor of the Willamette Valley in Marion County. At higher elevations, the average windspeed is somewhat greater and winds blow more frequently than at lower elevation. The following maximum windspeeds have been recorded for a period of at least 1 minute each during various months: 40 to 46 miles per hour (m.p.h.) for the months of November through February; 32 m.p.h. in April and May; 27 m.p.h. in June and July; 23 m.p.h. in August; 29 m.p.h. in September; and 38 m.p.h. in October. Winds that have the greatest velocity blow from the north and northwest during July and August, and from the south the rest of the year.

During the period of April through September, the daily windspeed increases gradually from a low of about 4 to 6 m.p.h. at daybreak to a high of about 10 to 11 m.p.h. between the hours of 4 and 6 in the afternoon. Stronger winds during the afternoon are caused mainly by convection. Air in the valley and above the lower slopes rises as it becomes warmer. Cooler, heavier air from the Pacific Ocean then begins to move up the valley to the Columbia River and into the valley of the Willamette River. These mild breezes that blow from the ocean in the afternoon explain why high temperatures are exceptional in the survey area.

Humidity.—As a rule, the relative humidity in Marion County is fairly high. It decreases to as low as 10 to 15 percent, however, during periods when masses of extremely dry continental air cross the Cascade Mountains from the east. The times when these masses of air invade the area coincide with the times when the temperature is either extremely low in winter or high in summer, and the low humidity helps to make the extreme temperatures less uncomfortable.

Significant from the standpoint of farming is the fact that relative humidities at night, especially during the early morning hours, closely approach 100 percent throughout the year. The average relative humidity at 4:00 a.m. in July, the driest month, is 87 percent. Because of this high humidity, heavy dew, which sometimes persists for several hours after sunrise, can be expected any time of the year.

Table 12 shows the average relative humidity, by months, recorded four times a day by the U.S. Weather Bureau Station at the Salem Airport. Relative humidity in the inland valleys is slightly different from that at the higher elevations. It is doubtful, however, if the average relative humidity would be significantly different from that at any elevation below 2,500 feet.

TABLE 12.—*Average relative humidity by months and time of day for Marion County*

Month	Time of day			
	4:00 a.m.	10:00 a.m.	4:00 p.m.	10:00 p.m.
	Pct.	*Pct.*	*Pct.*	*Pct.*
January	88	84	79	87
February	90	81	71	87
March	89	74	63	85
April	89	66	54	80
May	89	62	52	79
June	88	61	50	77
July	87	55	39	72
August	87	57	40	74
September	89	61	47	78
October	92	77	64	87
November	90	82	76	89
December	90	85	81	89
Year	89	70	60	82

Storms.—At any point on the floor of the Willamette Valley, thunderstorms occur on the average of six to eight times a year. Probably twice this number occur at the higher elevations on the slopes of the Cascade Mountains. Storms are mostly local, and the accompanying lightning generally does not do serious damage. Lightning often sets fire to trees that it strikes, and these fires, in turn, can start forest fires that destroy many thousands of acres of timber each year. Damage to property caused by lightning, other than that resulting from forest fires, is insignificant in most years.

Frequent hailstorms are likely to occur late in winter and early in spring. These storms usually produce only small hailstones. Storms that produce hailstones large enough to seriously damage buildings or crops occur, on the average, only about once each year in the entire survey area. Where these large stones fall, damage is generally confined to small areas, seldom more than 100 acres.

Less than a half dozen tornadoes or funnel clouds have been observed in the Willamette Valley and on the surrounding mountain slopes. Only three or four of these actually touched ground, and none of them touched ground for a distance wider than a few yards or longer than 300 to 400 feet.

Settlement and Development

Originally, the area that now includes Marion County comprised all that part of Oregon south and east of the mouth of the Pudding River, east to the summit of the Cascade Mountains, and south to the 42d parallel. This area was called the Champooick District. In 1837 part of this area was taken to form Linn County, and the boundary between Linn County and the rest of the Champooick District was established at the Santiam and North Santiam Rivers. In 1849 Marion County was formed from the rest of the Champooick District.

Development of the area now called Marion County began in 1834, when a settlement was established at Mission Bottom near the present site of Wheatland Ferry. A settlement had been established at Champoeg several years earlier, by employees of the Hudson Bay Company, but those settlers did not develop the area.

The population of Marion County was about 40,000 in 1910, and it had increased to 120,888 by 1960. Nearly half of the population lives in the vicinity of Salem, but many people live in Woodburn, Silverton, Stayton, and other parts of the county.

Farming is diversified, and the processing of food products and of timber into wood products are important industries. Processed fruits and vegetables, and paper, plywood, and other wood products, are important sources of income. Many plants where fruits and vegetables are processed are located in Salem, and additional facilities are located in Stayton, Silverton, and Woodburn. Livestock are marketed through buyers in Salem, Portland, and other cities in the Pacific Northwest. Several milk companies process the milk produced on farms in the survey area. Hard-surfaced roads, railways, bus lines, and airlines are available for transporting farm products to market.

Farming

The total acreage in farms in Marion County has declined somewhat in recent years, and the average size of farms has increased. In 1964, for example, the county had a total of 333,624 acres in 3,388 farms and the average size of farms was 98.5 acres. In contrast, the county had a total of 351,397 acres in 3,788 farms in 1959 and the average size of farms was only 92.8 acres.

The mild climate and the wide variety of soils make this county well suited to many different crops. The best soils can be used for all the crops adapted to the climate if they are irrigated. Soils that are shallower over bedrock or that have restricted drainage can be used for only a few specific crops. Pole beans and sweet corn are the leading cash crops, and acreages of those have increased during the past few years. The acreages will likely further increase as better facilities for irrigation are developed and as the population increases.

The following shows the acreages of the principal crops grown in Marion County in 1964, and also the number of the principal fruit trees and nut trees of all ages.

	Acres
Corn	6,660
Wheat:	
Winter	21,000
Spring	2,508
Oats	9,775
Barley	9,788
Alfalfa and alfalfa mixtures	5,089
Vetch or peas, alone or mixed with oats or other grains cut for hay	1,119
Oats, wheat, barley, rye, or other small grains cut for hay	1,811
Wild hay	1,907
Other hay	2,017
Grass silage made from grasses, alfalfa, clover, or small grains	2,056
Common ryegrass seed	1,944
Merion bluegrass seed	1,157
Bentgrass seed	4,863
Vetch seed	2,616
Mint for oil	2,941
Hops	3,302
Sweet corn	7,424
Snap beans (bush and pole)	8,588
Dry onions	1,452
Broccoli	961
Strawberries	3,959
Blackberries	1,962
	Number of trees of all ages
Sour cherries	19,532
Sweet cherries	131,575
English walnuts	29,099
Filberts	161,558

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Available water capacity (also termed 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 capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

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 clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found 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 and brittle; little affected by moistening.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors, such as light, moisture, temperature, and the physical condition of the soil are favorable.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Gleization. The reduction, translocation, and segregation of soil compounds, notably of iron, usually in the lower horizons, as a result of waterlogging with poor aeration and drainage; expressed in the soil by mottled colors dominated by gray. The soil-forming processes leading to the development of a gley soil.

Gleyed soil. A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.— The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of 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 these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Natural soil drainage. Refers to the conditions of frequence and duration of periods of saturation or partial saturation that existed during the development of the soil, 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 different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and in Podzolic soils commonly have mottling below 6 to 16 inches, in the lower A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Phase, soil. A subdivision of a soil series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape.

pH value. A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour", soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid.	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline.	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline.	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Site index. A numerical means of expressing the quality of a forest site that is based on the height of the dominant stand at an arbitrarily chosen age; for example, the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that 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: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows. I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.2 to 0.002 millimeter); IV (less than 0.002 millimeter).

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structures 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 (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

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."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

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