SOIL SURVEY OF WASCO COUNTY, OREGON, NORTHERN PART

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WASCO COUNTY, NORTHERN PART, is east of the Cascade Mountains in the north-central part of Oregon (see facing page). It occupies 559,730 acres.

The survey area is used mainly for farming. Sale of beef, wheat, and fruit is the principal source of farm income. Wheat is the main cash crop.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Wasco County, Northern Part; where they are located; and how they can be used. The soil scientists went into the county 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 classified and named the soils according to nationwide, uniform procedures. The soil phase is the category 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 geographic feature near the place where a soil of that series was first observed and mapped. Chenoweth and Dufur, for example, are the names of two soil series. All the soils in the United States having the same series name have essentially the same characteristics affecting their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, 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, Condon silt loam, 1 to 7 percent slopes, is one of several phases within the Condon 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 at the back of this publication was prepared from aerial photographs.

A mapping unit consists of all those areas shown on a soil map that are identified by the same symbol. 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. Two such kinds of mapping units are shown on the soil map of Wasco County, Northern Part: soil complexes and soil associations.

A soil complex consists of areas of two or more soils, so intermingled or so small they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Bakeoven-Condon complex, 2 to 20 percent slopes, is an example.

A soil association is made up of two or more soils that could be delineated individually but that are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. If there are two or more dominant series represented in the soil

association, the name ordinarily consists of the dominant soils joined by a hyphen. Bindle-Bins association, steep, is an example.

In most areas surveyed there are places where the soil is so stony, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called miscellaneous areas and are given descriptive names. Riverwash is a miscellaneous area.

Some of the mapping units in this survey area are broadly defined. These are indicated in the Index to Mapping Units and in the Guide to Mapping Units by an asterisk following the name of the mapping unit. The composition of these units is more variable than that of other units in the survey area, but mapping has been controlled well enough that interpretations can be made for the expected uses of the soil.

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

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, ox covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or to its high water table. They see that streets, road pavements, and foundations for houses are cracked on a particular soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They 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 current 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 Wasco County, Northern Part. 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 soil associations in Wasco County, Northern Part, are discussed in the following pages.

The soil associations in this survey area have been grouped into five general kinds of landscapes for broad interpretative purposes. Each of the broad groups and their included soil associations are described in the following ages. The terms for texture used in the title for several of the associations apply to the texture of the surface layer. For example, in the title of association 1, the words, silt loam and loam refer to the texture of the surface layer of the major soils named in the association. Terms used to express the dominant slope and depth of soil in the titles of the five major groups and the ten associations are defined in the Glossary. All the major soils in this survey area are well drained.

Deep, Moderately Sloping to Steep Soils on Uplands and Terraces

These soils are on uplands and old terraces in the northern part of the survey area along the Columbia River and its tributaries.

1. Cherryhill-Chenoweth association

Deep, moderately sloping to steep silt loam and loam soils

This association consists of moderately sloping to steep soils on the sides of canyons and dissected terraces along Three Mile, Five Mile, Mill, Chenoweth, and Mosier Creeks. These soils formed in old alluvium and in colluvium weathered from consolidated and semiconsolidated tuffaceous sandstone. In uncultivated areas, the vegetation is bunchgrasses, forbs, shrubs, Oregon white oak, and ponderosa pine. Slopes range from 1 to 50 percent but are dominantly 7 to 35 percent. Elevation ranges from 200 to 1,200 feet. The average annual precipitation ranges from 14 to 20 inches, and the average annual air temperature ranges from 51° to 54° F. The frost-free period is 140 to 210 days at 32° and 170 to 250 days at 28°.

This association makes up about 3 percent of the survey area. It is about 62 percent Cherryhill soils, 26 percent Chenoweth soils, and 12 percent Van Horn, Wind River, Hesslan, Skyline, Tygh, Endersby, and Cumulic Haplaquolls soils and Rock outcrop-Xeropsamments.

Cherryhill soils have a surface layer of very dark

grayish brown silt loam and a subsoil of dark brown and dark yellowish brown silt loam, sandy clay loam, and loam. Effective rooting depth is 40 to 60 inches.

Chenoweth soils have a surface layer of very dark brown and very dark grayish brown loam and a subsoil of dark brown loam. Effective rooting depth is 60 inches or more.

This association is used for irrigated and dryfarmed fruit orchards that are mostly sweet cherries (fig. 1), for wildlife habitat, and for water supply. The wildlife is mainly upland birds and deer.

Runoff is mainly from the steep soils where vegetative cover is in poor condition or has been removed by cultivation. Sediment from runoff is moderate. Maintaining maximum cover in orchards and using conservation practices on dryfarmed cropland minimize the hazard of erosion.

Shallow to Deep, Nearly Level to Steep Soils on Uplands

These soils are in the eastern part of the survey area in the Columbia District, Tygh Ridge, and Juniper Flat area.

They are well drained soils that formed mostly in loess, volcanic ash, and residuum weathered from basalt. Slopes range from 0 to 50 percent. Elevation ranges from 300 to 3,600 feet. The average annual precipitation ranges from 10 to 16 inches, and the average annual air temperature ranges from 45° to 52° F. The frost-free period is 100 to 170 days at 32° and 150 to 210 days at 28°.

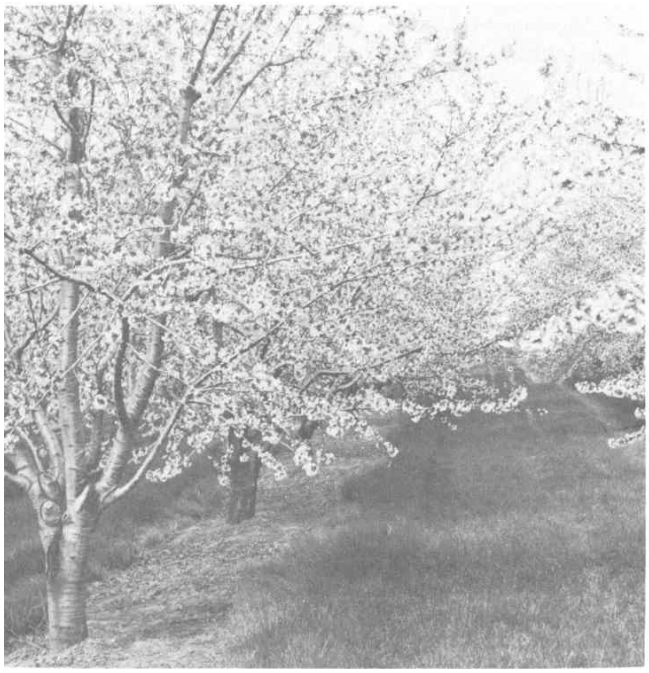

Figure 1: Irrigated sweet cherries with permanent cover crop on Chenoweth loam,1 to 7 percent slopes.

The four soil associations in this group make up about 46 percent of the survey area.

2. Walla Walla-Dufur association

Deep, nearly level to steep silt loam soils

This association consists of broad areas of soils that formed in loess on ridgetops and along major drainageways. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. Elevation ranges from 300 to 2,000 feet. The average annual precipitation ranges from 12 to 14 inches, and the average annual air temperature ranges from 48° to 52° F. The frost-free period is 120 to 170 days at 32° and 150 to 210 days at 28°.

This association makes up about 13 percent of the survey area. It is about 58 percent Walla Walla soils, 24 percent Dufur soils, and 18 percent Duart, Anderly, Wato, Endersby, Hermiston, Pedigo, Lickskillet, Nansene, and Wrentham soils and Riverwash.

Walla Walla soils have a surface layer of very dark brown silt loam and a subsoil of dark brown and brown silt loam. Effective rooting depth is 40 to 60 inches or more.

Dufur soils have a surface layer of very dark brown silt loam; a subsoil of dark brown, dark grayish brown, and dark yellowish brown silt loam; and a substratum of yellowish brown, moderately calcareous cobbly fine sandy loam. Effective rooting depth is 40 to 60 inches or more.

This association is used. for dryfarmed grain and pasture, wildlife habitat, and water supply. Farms are large, and water supplies for livestock are limited. The wildlife is mainly deer and upland birds.

Runoff is mainly from the moderately steep and steep soils, particularly in range where the grass is in poor condition and on summer fallow areas where vegetative protection is not provided. Sediment from runoff is moderate to high. Maintaining maximum cover on range and using conservation practices on dryfarmed cropland minimize the hazard of erosion.

3. Condon-Cantala Bakeoven association

Shallow to deep, nearly level to steep silt loam and very cobbly loam soils

The soils in this association formed in loess, volcanic ash, and residuum weathered from basalt. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. Elevation ranges from 1,600 to 3,600 feet. The average annual precipitation ranges from 10 to 13 inches, and the average annual air temperature ranges from 45° to 52° F. The frost-free period is 100 to 150 days at 32° and 150 to 200 days at 28 .

This association makes up about 19 percent of the survey area. It is about 44 percent Condon soils, 24 percent Cantala soils, 23 percent Bakeoven soils, and 9 percent Lickskillet, Wrentham, and Hermiston soils.

Condon soils are moderately deep and nearly level to steep. They have a surface layer of very dark brown silt loam and a subsoil of dark brown and very dark grayish brown silt loam. Effective roofing depth is 20 to 40 inches.

Cantala soils are deep and nearly level to steep. They have a surface layer of very dark brown and very dark grayish brown silt loam, a subsoil of dark brown silt loam, and a substratum of dark brown loam. Effective rooting depth is 40 to 60 inches or more.

Bakeoven soils are shallow and nearly level to moderately steep. They have a surface layer of dark brown very cobbly loam and a subsoil of dark brown very cobbly loam and very cobbly clay loam. Effective rooting depth is 5 to 12 inches.

This association is used for dryfarmed grain, range, and pasture; for wildlife habitat; and for water supply. Condon and Cantala soils are used for dryfarmed small grain. Bakeoven soils are used for grazing, mostly by cattle. Water supplies for livestock are limited. Springs and ponds are the main sources of water. The wildlife is mainly deer and upland birds.

Runoff is mainly from the shallow Bakeoven soils and the steep Condon and Cantala soils. Sediment from runoff is moderate to high. Maintaining maximum cover on range and using soil- and water-conserving practices on dryfarmed cropland minimize the hazard of erosion.

4. Watama-Bakeoven-Wapinitia association

Shallow to deep, nearly level to steep silt loam and very cobbly loam soils

This association consists of broad areas of soils on upland plateaus. These soils formed in loess, volcanic ash, and in residuum weathered from basalt. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. Elevation ranges from 1,800 to 3,400 feet. The average annual precipitation ranges from 13 to 16 inches, and the average annual air temperature ranges from 48° to 50° F. The frost-free period is 120 to 170 days at 32° and 170 to 200 days at 28 .

This association makes up about 7 percent of the survey area. It is about 39 percent Watama soils, 30 percent Bakeoven soils, 24 percent Wapinitia soils, and 7 percent Wamic, Hesslan, Maupin, and Wapinitia variant soils.

Watama soils are moderately deep and nearly level to steep. They have a surface layer of very dark brown and very dark grayish brown silt loam and a subsoil of dark brown loam and brown clay loam. Effective rooting depth is 20 to 40 inches.

Bakeoven soils are shallow and nearly level to moderately steep. They have a surface layer of dark brown very cobbly loam and a subsoil of dark brown very cobbly loam and very cobbly clay loam. Effective rooting depth is 5 to 12 inches

Wapinitia soils are deep and nearly level to steep. They have a surface layer of very dark brown silt loam, a subsoil of very dark brown silt loam and dark brown silty clay loam, and a substratum of dark yellowish brown fine sandy loam and dark brown clay loam. Effective rooting depth is 40 to 60 inches.

This association is used for dryfarmed grain, range, and pasture; for irrigated grain, hay, and pasture; for wildlife habitat; and for water supply. Bakeoven soils are used for grazing, mostly by cattle. The wildlife is mainly deer and upland birds.

Runoff is mainly from the shallow Bakeoven soils. Sediment from runoff is low to moderate. Maintaining maximum cover on range and using soil- and water-conserving practices on cropland minimize the hazard of erosion.

5. Maupin Bakeoven association

Shallow and moderately deep, nearly level to moderately steep loam and very cobbly loam soils

This association consists of broad areas of soils on upland plateaus. These soils formed in loess, volcanic ash, and residuum weathered from basalt. In uncultivated areas, the vegetation is bunchgrasses, forbs, shrubs, and juniper. Elevation ranges from 1,600 to 3,400 feet. The average annual precipitation ranges from 10 to 12 inches, and the average annual air temperature ranges from 45° to 52° F. The frost-free period is 120 to 170 days at 32° and 170 to 200 days at 28 .

This association makes up about 7 percent of the survey area. It is about 65 percent Maupin soils, 29 percent Bakeoven soils, and 6 percent Lickskillet, Hesslan, Sherar, and Maupin variant soils and Rock outcrop-Rubble land complex.

Maupin soils are moderately deep and nearly level or gently sloping. They have a surface layer of very dark grayish brown loam and a subsoil of dark brown loam. Effective rooting depth is 20 to 40 inches.

Bakeoven soils are shallow and nearly level to moderately steep. They have a surface layer of dark brown very cobbly loam and a subsoil of dark brown very cobbly loam and very cobbly clay loam. Effective rooting depth is 5 to 12 inches.

This association is used for dryfarmed grain, range, and pasture; for irrigated grain, hay, and pasture; for wildlife habitat; and for water supply. Bakeoven soils are used for grazing, mostly by cattle. The wildlife is mainly deer and upland birds.

Runoff is mainly from the shallow Bakeoven soils. Sediment from runoff is low to moderate. Maintaining maximum cover on range and using soil- and water-conserving practices on cropland minimize the hazard of soil erosion.

Shallow and Moderately Deep, Moderately Steep to Very Steep Soils on Uplands

These soils are on uplands in the eastern part of the survey area along the Deschutes River, Fifteenmile Creek, and their tributaries.

6. Lickskillet-Wrentham association

Shallow and moderately deep, moderately steep to very steep silt loam, very stony loam, and extremely stony loam soils

This association consists of soils on the sides of canyons along Fifteenmile Creek and the Columbia and Deschutes Rivers and soils on ridgetops (fig. 2). These

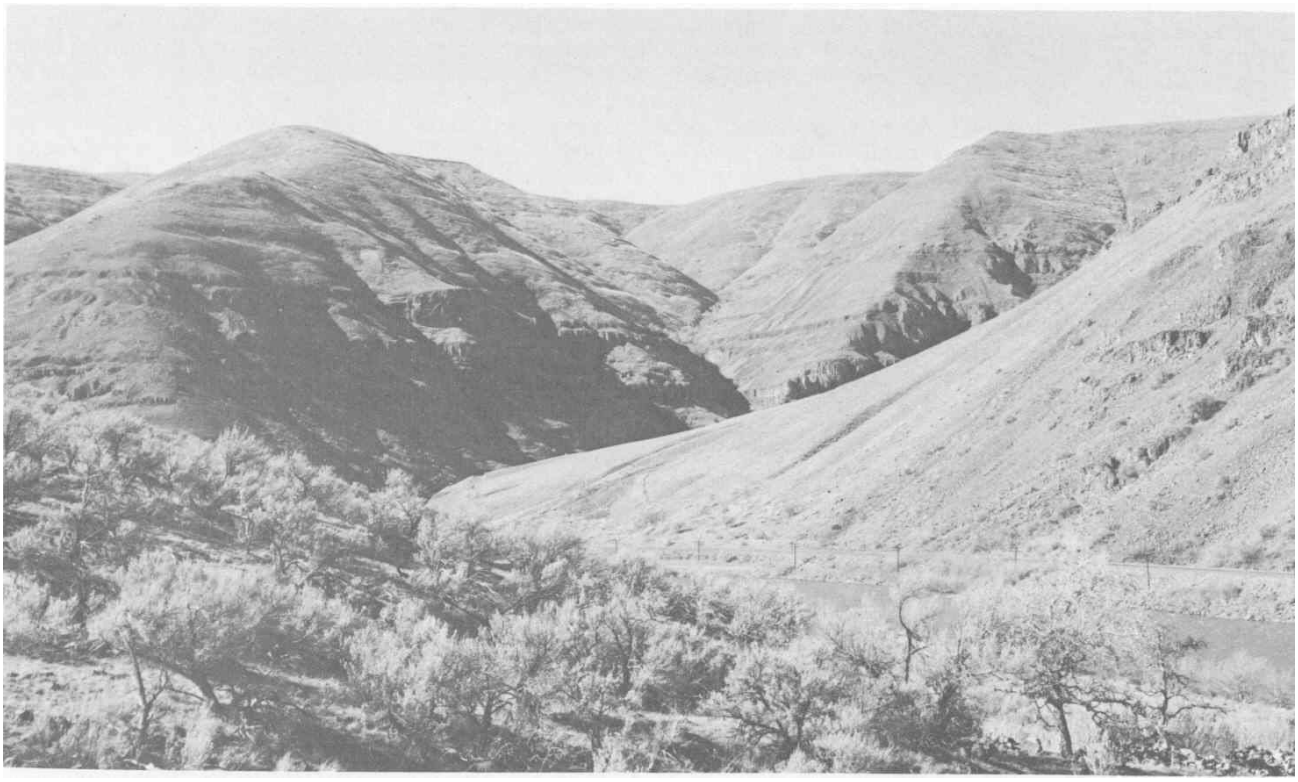

Figure 2: Typical area of the Lickskillet-Wrentham association. The south-facing soil is Lickskillet extremely stony loam, 40 to 70 percent slopes (mostly in right background), and the north-facing soil is Wrentham-Rock outcrop complex, 35 to 70 percent slopes (mostly in left background in areas of shadow). Bakeoven-Condon complex, 2 to 20 percent slopes, is on ridgetops.

soils formed in loess and in colluvium weathered from basalt. The vegetation is bunchgrasses, forbs, and shrubs. Slopes range from 15 to 70 percent. The average annual precipitation ranges from 10 to 13 inches, and the average annual air temperature ranges from 45° to 52° F. The frost-free period is 100 to 150 days at 32° and 150 to 210 days at 28°.

This association makes up about 18 percent of the survey area. It is about 59 percent Lickskillet soils, 17 percent Wrentham soils, and 24 percent Bakeoven, Anderly, Condon, Maupin, Watama, Warden, Nansene, Sherar, and Sinamox soils and Rock outcrop-Rubble land complex and Riverwash.

Lickskillet soils have a surface layer of very dark grayish brown extremely stony loam and a subsoil of dark brown very stony heavy loam and dark yellowish brown have gravelly heavy loam. Effective rooting depth is 12 to 20 inches.

Wrentham soils have a surface layer of very dark brown silt loam and a subsoil of dark brown very cobbly silty clay loam and silt loam. Effective rooting depth is 20 to 40 inches.

This association is used for range, wildlife habitat, and water supply. Ranches are large, and water supplies for livestock are limited. Springs and ponds are the main sources of water. The wildlife is mainly deer and upland birds.

Runoff is mainly from the shallow Lickskillet soils, particularly in areas of range where the grass is in poor condition. Sediment from runoff is low to moderate. Maintaining maximum cover on range minimizes the hazard of erosion.

Moderately Deep and Deep, Nearly Level to Very Steep Soils on Uplands of Tygh Valley

This group of soils is in the southeastern part of the survey area. The major soils are on uplands bordering White River and Tygh Creek in the Tygh Valley area.

7. Sherar-Sinamox association

Moderately deep and deep, nearly level to very steep cobbly loam and silt loam soils

This association consists of soils on upland plateaus. These soils formed in loess and gravelly colluvium. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. Elevation ranges from 1,500 to 2,500 feet. The average annual precipitation ranges from 10 to 12 inches, and the average annual air temperature is 48° to 52° F. The frost-free period is 120 to 170 days at 32° and 170 to 200 days at 28°.

This association makes up about 2 percent of the

survey area. It is about 46 percent Sherar soils, 26 percent Sinamox soils, and 28 percent Lickskillet, Bakeoven, Maupin, Pedigo, Quincy, and Tygh soils and Riverwash.

Sherar soils have a surface layer of very dark grayish brown cobbly loam and a subsoil of dark brown clay and gravelly clay. Effective rooting depth is 20 to 40 inches.

Sinamox soils have a surface layer of black and very dark grayish brown silt loam, a subsoil of dark brown silt loam, and a substratum of dark yellowish brown silty clay and brown gravelly clay loam. Effective rooting depth is 40 to 60 inches or more.

This association is used for dryfarmed grain and pasture, irrigated hay and pasture, wildlife habitat, and water supply. The wildlife is mainly deer and upland birds.

Runoff is mainly from the steep and very steep soils, particularly in areas of range where the grass is in poor condition and in areas of summer fallow where vegetation protection is not provided. Sediment from runoff is moderate to high. Maintaining maximum cover on ran e and using soil- and water-conserving practices on armed cropland minimize the hazard of erosion.

Shallow to Deep, Nearly Level to Very Steep Soils on Foot Slopes of the Cascade Mountains

This group of soils is in the western art of the survey area. They are loam, stony loam, gravelly loam, and very cobbly loam soils that formed in loess, volcanic ash, and in colluvium weathered from andesite and sandstone sediment. Slopes range from 1 to 70 percent. Elevation ranges from 500 to 3,600 feet. The average annual precipitation ranges from 14 to 30 inches, and the average annual air temperature ranges from 42° to 50° F. The frost-free period is 50 to 150 days at 32° and 90 to 200 days at 28°.

The three associations in this group make up about 31 percent of the survey area.

8. Hesslan-Skyline-Frailey association

Shallow to deep, nearly level to very steep stony loam, very cobbly loam, and loam soils

This association consists of soils on the sides of canyons along Fivemile, Fifteen Mile, and Mill Creeks and their tributaries and soils on ridgetops, side slopes, and bottom lands along streams. These soils formed in loess, in volcanic ash, and in colluvium weathered from sediment and sandstone. Vegetation is bunchgrasses, forbs, shrubs, Oregon white oak, ponderosa pine, and Douglas-fir. Elevation ranges from 500 to 3,500 feet. The average annual precipitation ranges from 14 to 30 inches, and the average annual air temperature ranges from 45° to 49° F. The frost-free period is 100 to 140 days at 32° and 120 to 160 days at 28°.

This association makes up about 9 percent of the survey area. It is about 45 percent Hesslan soils, 16 percent Skyline soils, 15 percent Frailey soils, and 24 percent Bald, Bodell, Ketchly, Wamic, and Tygh soils and Rock outcrop-Xeropsamments and Riverwash.

Hesslan soils have a surface layer of very dark grayish brown stony loam and a subsoil of dark brown loam and cobbly loam. Effective rooting depth is 20 to 40 inches.

Skyline soils have a surface layer of very dark grayish brown very cobbly loam and cobbly loam and a subsoil of dark brown gravely loam. Effective rooting depth is 12 to 20 inches.

Frailey soils have a surface layer of very dark grayish brown loam, a subsoil of dark brown loam, and a substratum of brown loam. Effective rooting depth is 40 to 60 inches or more.

This association is used for range, pasture, woodland, wildlife habitat, and water supply. The wildlife is mainly deer and upland birds.

Runoff is mainly from the very steep soils, particularly in areas of range where the grass is in poor condition and in logged-over areas where vegetative cover is sparse. Sediment from runoff is moderate or high. Maintaining maximum cover on range and using soil- and water-conserving practices on logged areas minimize the hazard of erosion.

9. Wamic Hesslan association

Moderately deep and deep, nearly level to very steep loam and stony loam soils

This association consists of soils that formed in loess, in volcanic ash, and in colluvium weathered from sandstone. In uncultivated areas, the vegetation is bunchgrass, forbs, shrubs, Oregon white oak, and ponderosa pine. Elevation ranges from 1,000 to 3,600 feet. The average annual precipitation ranges from 14 to 20 inches, and the average annual air temperature ranges from 46° to 50 F. The frost-free period is 100 to 150 days at 32° and 150 to 200 days at 28 .

This association makes up about 18 percent of the survey area. It is about 77 percent Wamic soils, 13 percent Hesslan soils, and 10 percent Bakeoven, Bald, Bodell, Frailey, Ketchly, Tygh, and Watama soils and Riverwash.

Wamic soils have a surface layer of very dark grayish brown loam, a subsoil of dark brown loam, and a substratum of dark brown heavy loam. Effective rooting depth is 40 to 60 inches or more.

Hessian soils have a surface layer of very dark grayish brown stony loam and a subsoil of dark brown loam and cobbly loam. Effective rooting depth is 20 to 40 inches.

This association is used for dryfarmed grain and pasture; irrigated grain, hay, and pasture; wildlife habitat; and water supply. Farms are large, and water supplies for livestock are limited. The wildlife is mainly deer and upland birds.

Runoff is mainly from areas of range where the grass is in poor condition and from areas of summer fallow where vegetation protection is not provided. Sediment from runoff is moderate to high. Maintaining maximum cover on ran e and using soil- and water-conserving practices on armed cropland minimize the hazard of erosion.

10. Ketchly-Bins association

Deep, nearly level to very steep loam and gravelly loam soils

This association consists of soils that formed in loess, in volcanic ash, and in colluvium weathered from andesite. Vegetation is shrubs, Douglas-fir, grand fir, and ponderosa pine. Elevation ranges from 1,100 to 3,600 feet. The average annual precipitation ranges from 25 to 30 inches, and the average annual air temperature ranges from 42° to 45° F. The frost-free period is 50 to 120 days at 32° and 90 to 140 days at 28°.

This association makes up about 4 percent of the survey area. It is about 57 percent Ketchly soils, 23 percent Bins soils, and 20 percent Bindle, Bald, Bodell, Wamic, Frailey, and Hesslan soils and Riverwash.

Ketchly soils have a surface layer of very dark grayish brown or dark brown loam and a subsoil of brown heavy loam. Effective rooting depth is 40 to 60 inches or more.

Bins soils have a surface layer of dark brown gravelly loam and a subsoil of dark brown loam and gravelly loam. Effective rooting depth is 40 to 60 inches or more.

This association is used for woodland, wildlife habitat, and water supply. The wildlife is mainly deer, elk, bear, and upland birds.

Runoff is mainly from the steep and very steep soils, particularly in recently logged areas. Sediment from runoff is low to moderate. Maintaining maximum cover on logging roads and skid trails and using soil- and water-conserving practices on logged areas minimize the hazard of erosion.

Descriptions of the Soils

In this section the soil series and mapping units in Wasco County, Northern Part, are described. Each soil series is described in detail, and then each mapping unit in that series is briefly described. Unless it is noted otherwise, what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for moist soil unless otherwise stated. The profile described in the series is representative of one of the mapping units in that series. If profile of a soil in a given mapping unit is different from the one described as representative of the series, these differences are stated in the description of the mapping unit or they are apparent in the name of the mapping unit, or both.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Cumulic Haplaquolls, for example, do not belong to a soil series; nevertheless, they are listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is the symbol that identifies the mapping unit on the detailed soil map. Listed at the end of the description of each mapping unit are the capability unit and range site in which the mapping unit has been placed. The pages on which each capability unit, range site, woodland group and windbreak group are described can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (11) .

Anderly Series

The Anderly series consists of well drained soils formed in loess and volcanic ash on uplands. Slopes are 3 to 35 percent. Elevation is 300 to 2,000 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 12 to 14 inches, the average annual air temperature is 50° to 52° F, and the frost-free period is 150 to 170 days at 32° and 170 to 210 days at 28°.

In a representative profile the surface layer is very dark grayish brown silt loam about 14 inches thick. The upper 15 inches of the subsoil is dark brown silt loam, and the lower 8 inches is brown silt loam. Basalt bedrock is at a depth of about 37 inches. The profile is neutral.

Permeability is moderate, and the available water capacity is 3 to 8 inches. Water-supplying capacity is 6 to 9 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

Representative profile of Anderly silt loam, 12 to 20 percent slopes, 500 feet east of a road in the NW1/4NW1/4NE1/4 section 32, T. 1 N., R. 15 E.:

Ap-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots many very fine irregular pores; neutral; abrupt clear boundary.

Al-7 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; slightly hard, friable slightly sticky and slightly plastic; many very fins roots; many very fine irregular pores; neutral; clear wavy boundary.

B21-14 to 29 inches; dark brown (10YR 3/3) silt loam brown (10YR 5/3) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear wavy boundary.

B22-29 to 37 inches brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic struc-

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

ture; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; neutral; abrupt wavy boundary.

IIR-37 inches; basalt bedrock.

The A horizon is very dark grayish brown or very dark brown when moist. The B2 horizon is grayish brown, brown, or pale brown when dry and dark brown or brown when moist. There is no lime accumulation in most places. Few basalt fragments, 1/8 to 1/2 inch in diameter, are throughout the profile. Depth to bedrock is 20 to 40 inches.

1C-Anderly silt loam, 7 to 12 percent slopes. A representative mapping unit is in the NW1/4NW1/4NE1/4 section 31, T. 1 N., R. 15 E. This soil is on broad ridgetops. Slopes average about 10 percent.

Included with this soil in mapping were areas of nearly level Anderly and Walla Walla soils that make up as much as 10 percent of the unit. Also included were Bakeoven and Lickskillet soils that make up as much as 5 percent.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-5; Rolling Hills range site.

1D-Anderly silt loam, 12 to 20 percent slopes. A representative mapping unit is in the NWl/4NW1/4NE1/4 section 32, T. 1 N., R. 15 E. This soil is in long, narrow areas and has south-facing slopes. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Walla Walla, Bakeoven, and Lickskillet soils. These soils make up as much as 15 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-7 ; Rolling Hills range site.

1E-Anderly silt loam, 20 to 35 percent slopes. A representative mapping unit is in the NE1/4SW1/4SE1/4 section 29, T. 1 N., R. 15 E. This soil is in long, narrow areas and has south-facing slopes.

Included with this soil in mapping were areas of Walla Walla, Bakeoven, and Lickskillet soils. These soils make up as much as 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is high. Capability subclass VIe; Droughty South Exposure range site.

Bakeoven Series

The Bakeoven series consists of well drained soils formed on uplands in a thin layer of loess and the underlying residuum weathered from basalt. Slopes are 2 to 20 percent. Elevation is 1,600 to 3,600 feet. The vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 45° to 52° F, and the frost-free period is 110 to 150 days at 32° and 150 to 200 days at 28°.

In a representative profile the surface layer is dark

brown very cobbly loam about 3 inches thick. The subsoil is dark brown very cobbly loam and very cobbly clay loam about 6 inches thick. Basalt bedrock is at a depth of about 9 inches. The profile is neutral.

Permeability is moderately slow, and the available water capacity is .15 to .7 inches. Water-supplying capacity is less than 2.5 inches. Effective rooting dept is 4 to 1 inches.

These soils are used for range, wildlife habitat, and water supply.

Representative profile of Bakeoven very cobbly loam, 2 to 20 percent slopes, 100 feet southeast of a road in the SE1/4SE1/4NE1/4 section 16, T. 3 S., R. 14 E.:

A1-0 to 3 inches; dark brown (7.5YR 3/2) very cobbly loam, brown (10YR 5/3) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 30 percent pebbles, 25 percent cobbles and 5 percent stones; neutral; abrupt smooth boundary.

B1-3 to 6 inches; dark brown (7.5YR 3/3) very cobbly loam, brown (7.5YR 4/4) dry; weak fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 30 percent pebbles, 30 percent cobbles, and 5 percent stones; neutral; abrupt smooth boundary.

B2-6 to 9 inches; dark brown (10YR 3/3) very cobbly clay loam, brown (7.5YR 4/4) dry; moderate fine subangular blocky structure; hard, friable, sticky and plastic; common fine roots; common very fine tubular pores; 30 percent pebbles, 50 percent cobbles, and 10 percent stones; neutral; abrupt wavy boundary.

IIR-9 inches; basalt bedrock.

The A horizon is brown or grayish brown when dry and dark brown or very dark grayish brown when moist. It is very cobbly loam, very stony loam, or extremely stony loam. The B2 horizon is brown, dark brown, or yellowish brown when dry and dark brown or dark yellowish brown when moist. The B horizon is 50 to 90 percent rock fragments. Depth to bedrock is 4 to 12 inches.

2D-Bakeoven very cobbly loam, 2 to 20 percent slopes. A representative mapping unit is in the SE1/4SE1/4NE1/4 section 16, T. 3 S., R. 14 E. This soil is in long, narrow areas between Condon soils on ridgetops and Lickskillet soils on south-facing canyon slopes. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Condon, Maupin, Wapinitia, Watama, and Lickskillet soils. These soils make up as much as 15 percent of the unit.

Runoff is slow to rapid, and the hazard of erosion is moderate. Capability subclass VIIs; Scabland range site.

3D-Bakeoven-Condon complex, 2 to 20 percent slopes. A representative mapping unit is in the NE1/4NE1/4NW1/4 section 15, T. 3 S:, R. 14 E. This complex is about 50 to 85 percent Bakeoven very cobbly loam; 2 to 20 percent slopes, and 10 to 35 percent a Condor silt loam that has 2 to 20 percent slopes. The Bakeoven soil has the profile described as representative of the series. It is on ridgetops or side slopes in areas of scabland between and around areas of the Condon soil The Condon soil is generally on ridgetops or side slope, in circular or elongated mounds.

Included with this complex in mapping were areas of a Lickskillet very stony loam and shallow stony soils. These soils make up as much as 15 percent of the unit.

Runoff is slow to rapid, and the hazard of erosion is slight to moderate. Capability subclass VIIs; Bakeoven soil in Scabland range site; Condon soil in Rolling Hills range site.

4C-Bakeoven-Maupin complex, 0 to 12 percent slopes. A representative mapping unit is in the NW1/4SW1/4NW1/4 section 2, T. 5 S., R. 13 E. This complex is about 50 to 85 percent a Bakeoven very stony loam and 10 to 35 percent a Maupin loam (fig. 3). It is on upland plateaus. The Bakeoven soil is in areas of scabland between and around areas of the Maupin soil. The Maupin soil commonly is on circular or elongated mounds. The Bakeoven soil has a profile similar to the one described as representative of the Bakeoven series, but it is very stony.

Included with this complex in mapping were areas of Lickskillet soils that make up as much as 15 percent of the unit.

Runoff is slow to rapid, and the hazard of erosion is slight to moderate. Capability subclass VIIs; Bakeoven soil in Scabland range site; Maupin soil in Shrubby Rolling Hills range site.

5C-Bakeoven-Watama complex, 0 to 12 percent slopes. This complex is about 50 to 85 percent a Bakeoven very stony loam that has 2 to 12 percent slopes, and 10 to 35 percent a Watama silt loam that has 0 to 12 percent slopes. The Bakeoven soil is in areas of scabland between and around the Watama soil. The Watama soil is in circular mounds that have a convex surface. The soil near the center of the mound is deeper to bedrock than near the edges. Where the slope is more than 10 percent, the Watama soil commonly occurs as elongated mounds and the long axis is downslope. The mounds are 15 to 40 feet in diameter and about 25 feet apart. The Bakeoven soil has a profile similar to the one described as representative of the series, but it is very stony.

Included with this complex in mapping were areas of Lickskillet soils, shallow stony soils, and Rock outcrop. These soils make up as much as 15 percent of the unit.

Runoff is slow to medium, and the hazard of erosion is slight to moderate. Capability subclass VIIs; Bakeoven soil in Scabland range site; Watama soil in Shrubby Rolling Hills range site.

Bald Series

The Bald series consists of well drained soils formed in loess and volcanic ash and the underlying colluvium weathered from basalt on uplands. Slopes are 5 to 75 percent. Elevation is 200 to 3,000 feet. The vegetation is oak, pine, fir, bunchgrasses, forbs, and shrubs. The average annual precipitation is 20 to 30 inches, the average annual air temperature is 48° to 51° F, and the frost-free period is 100 to 140 days at 32° and 140 to 180 days at 28°.

Figure 3: Bakeoven very stony loam, 0 to 12 percent slopes, is in the foreground. Maupin loam, 0 to 12 percent slopes, is on the round mounds In the background.

In a representative profile the surface layer is dark brown cobbly loam and dark reddish brown gravelly loam about 12 inches thick. The subsoil is dark reddish brown and reddish brown very gravelly loam about 25 inches thick. Basalt bedrock is at a depth of about 37 inches. The surface layer is neutral, and the subsoil is slightly acid.

Permeability is moderate, and the available water capacity is 2 to 5 inches. Water-supplying capacity is 12 to 25 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for range, timber production, wildlife habitat, and water supply.

Representative profile of Bald cobbly loam, 5 to 45 percent slopes, in the SE1/4SE1/4NE1/4 section 36, T. 2 N., .11 E.:

O1-1/2 inch to 0; oak leaves, pine twigs, and needles.

A1-0 to 5 inches; dark brown (7.5YR 3/2) cobbly loam, reddish brown (5YR 4/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; 20 percent pebbles, 20 percent cobbles; neutral; clear smooth boundary.

A12-5 to 12 inches; dark reddish brown (5YR 3/3) gravelly loam, reddish brown (5YR 4/4) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 30 percent pebbles, 15 percent cobbles; neutral; gradual wavy boundary.

B21-12 to 21 inches; dark reddish brown (5YR 3/4) very gravelly heavy loam, reddish brown (5YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 35 percent pebbles, 25 percent cobbles; slightly acid; gradual wavy boundary.

B22-21 to 37 inches; reddish brown (5YR 4/4) very gravelly heavy loam, yellowish red (5YR 5/6) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 40 percent pebbles, 30 percent cobbles; slightly acid; abrupt wavy boundary.

IIR-37 inches; basalt bedrock, partly fractured.

The A horizon has fine or medium granular structure and is 15 to 45 percent rock fragments. The B2 horizon is loam, heavy loam, or light clay loam and is more than 35 percent cobbles and pebbles. It has weak to moderate, fine to medium, subangular blocky structure. Depth to bedrock is 20 to 40 inches.

6E-Bald cobbly loam, 5 to 45 percent slopes. A representative mapping unit is in the SE1/4SE1/4NE1/4 section 36, T. 2 N., R. 11 E. This soil is in irregularly shaped areas and has south-facing slopes. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Bodell and Wamic soils. These soils make up about 15 percent of the unit.

Runoff is slow to rapid, and the hazard of erosion is slight to severe. Capability subclass VIs; Pine-Douglas Fir-Sedge range site; woodland group 4f.

7F-Bald very cobbly loam, 45 to 75 percent slopes. A representative mapping unit is in the NW1/4NW1/4NW1/4 section 18, T. 2 N., R. 13 E. This soil is in long, narrow areas and has south-facing slopes. It has a profile similar to the one described as representative of the series, but the surface layer is more than 50 percent rock fragments.

Included with this soil in mapping were areas of Bodell and Wamic soils. These soils make up about 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIs; Oak-Pine Steep South range site; woodland group 4f.

Bald Variant

The Bald variant consists of well drained soils formed in loess and volcanic ash and the underlying colluvium weathered from basalt on uplands. Slopes are 45 to 75 percent. Elevation is 200 to 2,500 feet. The vegetation is Douglas-fir, bigleaf maple, forbs, and shrubs. The average annual precipitation is 22 to 30 inches, the average annual air temperature is 48° to 51° F, and the frost-free period is 100 to 140 days at 32°.

In a representative profile the surface layer is very dark grayish brown cobbly loam about 5 inches thick. The subsoil is dark brown cobbly loam, gravelly loam, and very gravelly loam about 35 inches thick. The substratum is brown very gravelly loam about 22 inches thick. The surface layer is slightly acid, and the subsoil and substratum are neutral.

Permeability is moderate, and the available water capacity is 4 to 8 inches. Water-supplying capacity is 16 to 20 inches. Effective rooting depth is 40 to 60 inches.

These soils are used for woodland, wildlife habitat, and water supply.

Representative profile of Bald variant cobbly loam, 45 to 75 percent slopes, in the NE1/4SE1/4SE1/4 section 34, T. 3 N., R. 8 E.

O1-2 inches to 0; pine needles, twigs, and leaves.

A1-0 to 5 inches; very dark grayish brown (10YR 3/2) cobbly loam; grayish brown (10YR 5/2) dry; moderate fine granular structure; slightly hard, friable, slight (y sticky and slightly plastic; many very fine roots; many very fine irregular ores; 10 percent pebbles, 15 percent cobbles; slightly acid; gradual wavy boundary.

B1-5 to 12 inches; dark brown (10YR 3/3) cobbly loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine tubular pores; 15 percent pebbles, 15 percent cobbles; neutral; gradual wavy boundary.

B21-12 to 23 inches; dark brown (7.5YR 3/3) gravelly loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many medium fine and very fine roots; many very fine tubular pores; 30 percent pebbles, 10 percent cobbles; neutral; gradual wavy boundary.

B22-23 to 40 inches; dark brown (7.5YR 4/3) very gravelly loam, brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots many very fine tubular pores; 45 percent pebbles, 20 percent cobbles; neutral; gradual wavy boundary.

C1-40 to 62 inches; brown (7.5YR 4/4) very gravelly loam, light brown (10YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; common very fine tubular pores; 50 percent pebbles, 35 percent cobbles; neutral.

The A horizon is very dark grayish brown or dark reddish brown and is 25 to 50 percent rock fragments. The B horizon is dark brown or brown and is 50 to 80 percent rock fragments. It has weak or moderate structure. Depth to bedrock is 40 to 60 inches or more.

8F-Bald variant cobbly loam, 45 to 75 percent slopes. A representative mapping unit is in the NE1/4SE1/4SE1/4, section 34, T. 3 N., R. 8 E. This soil is in long areas and has north-facing slopes.

Included with this soil in mapping were areas of Bald, Bodell, and Bindle soils. These soils make up about 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIs; woodland group 2f.

Bindle Series

The Bindle series consists of well drained soils formed in loess, volcanic ash, and the underlying stony colluvium weathered from andesite on uplands. Slopes are 1 to 70 percent. Elevation is 2,500 to 3,500 feet. The vegetation is Douglas-fir, grand fir, bunchgrasses, forbs, and shrubs. The average annual precipitation is 25 to 30 inches, the average annual air temperature is 42° to 45° F, and the frost-free period is 50 to 100 days at 32° and 90 to 130 days at 28°.

In a representative profile the surface layer is dark brown gravelly loam about 6 inches thick. The upper 9 inches of the subsoil is dark brown gravelly loam, and the lower 7 inches is dark brown very gravelly heavy loam. Depth to highly fractured bedrock is 20 to 40 inches. The surface layer is neutral, and the subsoil and substratum are slightly acid to medium acid.

Permeability is moderate, and the available water capacity is 4 to 7 inches. Water-supplying capacity is 13 to 20 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for timber, wildlife habitat, and water supply.

Representative profile of Bindle gravelly loam in an area of Bindle-Bins association, steep, south of road in the NE1/4SW1/4 section 23, T. 1 N., R. 10 E.:

O1-1 1/2 inches to 0; fir twigs and needles.

A1-0 to 6 inches; dark brown (7.5YR 3/2) gravelly loam, brown (7.5YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very tine and few medium roots; many very fine irregular pores; 25 percent pebbles; slightly acid; clear smooth boundary.

B21-6 to 15 inches; dark brown (7.5YR 3/3) gravelly loam, brown (7.5YR 5/3) dry; moderate fine granular structure and moderate very fine subangular blocky

structure slightly hard, friable, slightly sticky and slightly plastic; many very fine and few medium roots; many very fine tubular pores; 25 percent pebbles, 10 percent cobbles; slightly acid; gradual wavy boundary.

B22-15 to 22 inches; dark brown (7.5YR 4/2) very gravelly heavy loam, brown (7.5YR 5/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and medium roots; many very fine tubular pores; 35 percent pebbles, 15 percent cobbles; medium acid; gradual wavy boundary.

IIC-22 to 60 inches; highly fractured bedrock with horizontal s acing between cracks less than 4 inches; fines are too few to fill some of the interstices larger than 1 millimeter; fines are dark brown (7.5YR 4/4) loam, brown (7.5YR 5/4) dry; slightly hard, friable, slightly sticky and slightly plastic; many fine roots in fractures; many very fine irregular pores; 30 percent stones; 40 percent cobbles, and 15 percent pebbles; medium acid.

The A horizon is reddish brown or brown when dry and dark brown or dark reddish brown when moist. It is 20 to 40 percent pebbles and as much as 10 percent stones. The B horizon is reddish brown or brown when dry and dark reddish brown or dark brown when moist. It is 20 to 40 percent pebbles, 5 to 20 percent cobbles, and as much as 10 percent stones. Depth to highly fractured bedrock is 20 to 40 inches.

9E-Bindle-Bins association, steep. A representative mapping unit is in the NWl/4NW1/4 section 22, T. 1 N., R. 11 E. This association is about 55 percent a Bindle gravelly loam that has 1 to 30 percent slopes and 30 percent a Bins gravelly loam that has l to 30 percent slopes. The Bindle soil is on narrow ridges and the upper part of slopes capped with rock. The Bins soil is in irregularly shaped areas on broad ridgetops not capped by rock. Both soils have the profile described as representative of their respective series.

Included with this association in mapping were areas of very stony shallow soil, ashy soils, an Rock outcrop that make up as much as 15 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Bindle soil in capability subclass VIs; woodland group 3f. Bins soil in capability subclass VIe; woodland group 2o.

9F-Bindle-Bins association, very steep. A representative mapping unit is in the NE1/4SW1/4 section 23, T. 1 N., R. 10 E. This association is about 45 percent a Bindle gravelly loam that has 30 to 70 percent slopes and 40 percent a Bins gravelly loam that has 30 to 70 percent slopes. The Bindle soil is on the top and convex part of slopes in areas capped by rock. The Bins soil is on the middle and lower parts of slopes not capped by rock. The Bins soil has a profile similar to the one described as representative of the Bins series, but it contains more rock fragments.

Included with this association in mapping were areas of shallow very stony soils, Bold variant soils, and Rock outcrop that make up as much as 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Bindle soil in capability subclass VIIs; woodland group 3f; Bins soil in capability subclass VIIe; woodland group 2r.

Bins Series

The Bins series consists of well drained soils formed in loess, volcanic ash, and the underlying stony, moderately fine textured colluvium weathered from andesite on uplands. Slopes are 1 to 70 percent. Elevation is 1,100 to 3,600 feet. The vegetation is Douglas-fir, grand fir, forbs, and shrubs. The average annual precipitation is 25 to 30 inches, the average annual air temperature is 42° to 45° F, and the frost-free period is 50 to 100 days at 32° and 90 to 130 days at 28°.

In a representative profile the surface layer is dark brown gravelly loam about 8 inches thick. The subsoil is dark brown loam and gravelly loam about 28 inches thick. The substratum is dark brown cobbly clay loam about 24 inches thick. Basalt bedrock is at a depth of about 40 to more than 60 inches.

Permeability is moderately slow, and the available water capacity is 7 to 12 inches. Water-supply capacity is 17 to 20 inches. Effective rooting depth is 40 to 60 inches or more.

These soils are used for timber, wildlife habitat, and water supply.

Representative profile of a Bins gravelly loam in an area of Bindle-Bins association, steep, in the SEl/4SW1/4SE1/4 section 15, T. 1 N., R. 11 E.:

O1-1 inch to 0; fir twigs and needles.

A1-0 to 8 inches; dark brown (7.5YR 3/2) gravelly loam, brown (7.5YR 5/2) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine and medium roots; many very fine irregular pores; 25 percent fine pebbles; slightly acid; clear smooth boundary.

B1-8 to 12 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 5/3) dry; weak medium granular structure; slight l hard, friable, slightly sticky and slightly plastic; many very tine roots; many very fine tubular pores; 10 percent pebbles; slightly acid; gradual smooth boundary.

B21-12 to 25 inches; dark brown (7.5YR 4/3) gravelly loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; 15 percent pebbles, 10 percent cobbles; many very fine tubular pores; slightly acid; gradual wavy boundary.

B22-25 to 36 inches; dark brown (7.5YR 4/4) gravelly heavy loam, reddish brown (5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, fable, slightly sticky and slightly plastic, common very fine roots; many very fine tubular pores; few thin clay films in pores; 20 percent pebbles, 5 percent cobbles; slightly acid; clear wavy boundary.

C-36 to 60 inches; dark brown (7.5YR 4/4) cobbly clay loam, reddish brown (5YR 5/4) dry; massive; slightly hard, friable, sticky and plastic; common very fine roots; common very fine and fine irregular pores; slightly acid.

The A horizon is dart, reddish gray or brown when dry. It is 15 to 25 percent fine pebbles 1/8 to 1/2 inch in diameter and 0 to 15 percent cobbles and stones. The B horizon and C horizon are loam, heavy loam, or clay loam. They are 0 to 15 percent pebbles and 0 to 20 percent cobbles. Depth to bedrock is 40 to 60 inches or more. Bin soils are mapped only in association with Bindle soils in two mapping units. Refer to the Bindle series for a description of these mapping units.

Bodell Series

The Bodell series consists of well drained soils formed in loess and volcanic ash and the underlying colluvium weathered from basalt on uplands. Slopes are 5 to 75 percent. Elevation is 200 to 2,500 feet. The

vegetation in bunchgrasses, forbs, shrubs, and scattered oak trees. The average annual precipitation is 20 to 30 inches, the average annual air temperature is 48° to 51° F, and the frost-free period is 100 to 140 days at 32° and 140 to 180 days at 28 .

In a representative profile the surface layer is dark brown cobbly loam about 5 inches thick. The upper 8 inches of the subsoil is dark brown very cobbly loam, and the lower 5 inches is dark brown very cobbly clay loam. Basalt bedrock is at a depth of about 18 inches. The soil material throughout the profile is neutral.

Permeability is moderate, and the available water capacity is 1 inch to I inches. Water-supplying capacity is 4 to 7 inches. Effective rooting depth is 12 to 20 inches.

These soils are used for range, wildlife habitat, and water supply.

Representative profile of Bodell cobbly loam, 5 to 45 percent slopes, 100 feet north of road in the NW1/4SW1/4SW1/4 section 33, T. 2 N., R. 12 E.:

A1-0 to 5 inches; dark brown (7.5YR 3/2) cobbly loam, brown (7.5YR 4/3) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 15 percent pebbles, 20 percent cobbles; neutral; abrupt smooth boundary.

B21-5 to 13 inches; dark brown (7.5YR 3/3) very cobbly loam, brown (7.5YR 4/3) dry; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular and irregular pores; 20 percent pebbles, 40 percent cobbles; neutral; clear smooth boundary.

B22-13 to 18 inches; dark brown (7.5YR 3/3) very cobbly clay loam, brown (7.5YR 3/3) dry; weak fine subangular blocky structure; hard, firm, sticky and plastic; plentiful very fine roots; many very fine irregular and tubular pores; 60 percent cobbles, 10 percent stones; neutral; abrupt smooth boundary.

IIR-18 inches; basalt bedrock.

The A horizon is brown, grayish brown, or dark grayish brown when dry and dark brown or very dark grayish brown when moist. It is 20 to 40 percent pebbles and 0 to 10 percent cobbles. The B2 horizon is brown or dark yellowish brown when dry and dark brown or dark yellowish brown when moist. It is very cobbly loam to very cobbly clay loam and is 18 to 30 percent clay. It is 50 to 70 percent rock fragments, mainly cobbles. Depth to bedrock is 12 to 20 inches.

10E-Bodell cobbly loam, 5 to 45 percent slopes. A representative mapping unit is in the NW1/4SW1/4SW1/4 section 33, T. 2 N., R. 12 E. This soil is in irregularly shaped areas and has south-facing slopes. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Bald, Ketchly, and Wamic soils. These soils make up as much as 15 percent of the unit.

Runoff is slow to rapid, and the hazard of erosion is slight to severe. Capability subclass VIIs; South Exposure range site.

11F-Bodell very cobbly loam, 45 to 75 percent slopes. A representative mapping unit is in the NE1/4NW1/4 section 14, T. 1 N., R. 12 E. This soil is in long, narrow areas and has south-facing slopes. This soil has a profile similar to the one described as representative of the series, but the surface layer is more than 50 percent rock fragments.

Included with this soil in mapping were areas of Bald, Ketchly, and Wamic soils. These soils make up as much as 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIs; Steep South range site.

Cantala Series

The Cantala series consists of well drained soils formed in loess that has an appreciable content of volcanic ash overlying stratified alluvium on uplands. Slopes are 1 to 35 percent. Elevation is 1,600 to 3,600 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 45° to 52° F, and the frost-free period is 100 to 150 days at 32° and 150 to 200 days at 28°.

In a representative profile the surface layer is very dark brown and very dark grayish brown silt loam about 18 inches thick. The subsoil is dark brown silt loam about 36 inches thick. The substratum is dark brown loam about 8 inches thick. The surface layer and subsoil are neutral, and the substratum is mildly alkaline.

Permeability is moderate, and the available water capacity is 6 to 12 inches. Water-supplying capacity is 9 to 12 inches. Effective rooting depth is 40 to 60 inches or more.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

Representative profile of Cantala silt loam, 1 to 7 percent slopes, 65 feet west of the county road in SE1/4SEl/4SE1/4 section 5, T. 2 S., R. 15 E.:

Ap-0 to 8 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.

A12-8 to 13 inches; very dark brown (10YR 2/2) silt loam grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear smooth boundary.

A13-13 to 18 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear smooth boundary.

B21-18 to 35 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, fable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear smooth boundary.

B22-35 to 54 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear wavy boundary.

IIC-54 to 62 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; hard, friable, nonsticky and nonplastic; few very fine and fine roots; many very fine tubular pores; many noncalcareous nodules 1/4

to 1 inch in diameter; few mycelia lime below a depth of 60 inches; mildly alkaline.

IIIR-62 inches; basalt bedrock.

The B2 horizon is silt loam and is 18 to 24 percent clay. It is less than 15 percent rock fragments coarser textured than very fine sand. It has weak or moderate structure. The C horizon is stratified sand or silt in some places.

12B-Cantala silt loam, 1 to 7 percent slopes. A representative mapping unit is in the SE1/4SEI/4SE1/4 section 5, T. 2 S., R. 15 E. This soil is on broad ridgetops in long, broad areas. Slopes average about 5 percent. The soil has the profile describes representative of the series.

Included with this soil in mapping were areas of Bakeoven, Condon, Lickskillet, and Wrentham soils. These soils make up about 10 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-3; Rolling Hills range site.

12C-Cantala silt loam, 7 to 12 percent slopes.

A representative mapping unit is in the SW1/4SW1/4SW1/4 section 34, T. 1 S., R. 14 E. This soil is on broad ridgetops in long, broad areas.

Included with this soil in mapping were areas of Bakeoven, Condon, Lickskillet, and Wrentham soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; Rolling Hills range site.

12D-Cantala silt loam, 12 to 20 percent slopes.

A representative mapping unit is in the NE1/4NE1/4NE1/4 section 10, T. 2 S., R. 15 E. This soil is in long, broad areas and has north-facing slopes.

Included with this soil in mapping were areas of Bakeoven, Condon, Lickskillet, and Wrentham soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-4; Droughty North Exposure range site.

12E-Cantala silt loam, 20 to 35 percent slopes.

A representative mapping unit is in the SE1/4NE1/4NW1/4 section 1, T. 2 S., R. 14 E. This soil is in long, irregularly shaped areas and has north-facing slopes.

Included with this soil in mapping were areas of Bakeoven, Condon, Lickskillet, and Wrentham soils. These soils make up about 10 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability unit IVe-3 ; North Exposure range site.

Chenoweth Series

The Chenoweth series consists of well drained soils formed in old alluvium on uplands. Slopes are 1 to 35 percent. Elevation is 200 to 950 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, shrubs, and ponderosa pine. The average annual precipitation is 14 to 20 inches, the average annual air temperature is 51° to 54° F, and the frost-free period is 150 to 210 days at 32° and 185 to 250 days at 28 .

In a representative profile the surface layer is very dark brown and very dark grayish brown loam about 22 inches thick. The subsoil is dark brown loam about 24 inches thick. The upper 9 inches of the substratum is brown loam, and the lower part is brown very fine sandy loam to a depth of 60 inches or more. The soil material throughout the profile is neutral.

Permeability is moderate, and the available water capacity is 7.5 to 9.0 inches. Water-supplying capacity is 10 to 12 inches. Effective rooting depth is 60 inches or more.

These soils are used mostly for fruit orchards and some range.

Representative profile of Chenoweth loam, 1 to 7 percent slopes, 1/2 mile south of The Dalles city limits on Glen Cooper farm in the NE1/4SE1/4SW1/4 section 10, T. 1 N., R. 13 E.:

Ap1-0 to 5 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; weak medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine ad fine irregular pores; neutral; abrupt smooth boundary.

Ap2-5 to 11 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; weak thick platy and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine tubular pores; neutral; clear smooth boundary.

A3-11 to 22 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine tubular pores; few noncalcareous nodules as much as 1 inch in diameter; neutral; gradual smooth boundary.

B21-22 to 34 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine tubular pores; many noncalcareous very dark grayish brown (10YR 3/2) nodules as much as 1 inch in diameter; neutral; gradual smooth boundary.

B22-34 to 46 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine tubular pores; few noncalcareous nodules as much as 1 inch in diameter; neutral; gradual smooth boundary.

CI-46 to 55 inches; brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; massive; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many fine an few medium tubular pores; neutral; gradual smooth boundary

C2-55 to 88 inches; brown (10YR 4/3) very fine sandy loam, pale brown (10YR 6/3) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many medium tubular pores; neutral.

The A horizon is loam or very fine sandy loam. The B2 horizon is silt loam, loam, or very fine sandy loam. It is as much as 18 percent clay and more than 15 percent particles coarser textured than very fine sand. The C horizon is loam or very fine sandy loam. It has iron staining and lime accumulations in places.

13B-Chenoweth loam, 1 to 7 percent slopes. A representative mapping unit is in the NW1/4SE1/4SW1/4 section 10, T. 1 N., R. 13 E. This soil is on ridgetops in broad areas. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Cherryhill, Wind River, Van Horn, Frailey, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-1; Pine-Oak-Fescue range site.

13C-Chenoweth loam, 7 to 12 percent slopes. A representative mapping unit is in the NE1/4NE1/4NE1/4 section 22, T. 1 N., R. 13 E. This soil is on ridgetops in long, broad areas.

Included with this soil in mapping were areas of Cherryhill, Wind River, Van Horn, Frailey, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-2; Pine-Oak-Fescue range site.

13D-Chenoweth loam, 12 to 20 percent slopes. A representative mapping unit is in the NE1/4NW1/4NW1/4 section 14, T. 1 N., R. 13 E. This soil is in long, irregularly shaped areas.

Included with this soil in mapping were areas of Cherryhill, Wind River, Van Horn, Frailey, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-2; Pine-Oak-Fescue range site.

13E-Chenoweth loam, 20 to 35 percent slopes. A representative mapping unit is in the NE1/4NE1/4SW1/4 section 14, T. I N., R. 13 E. This soil is in long, irregularly shaped areas.

Included with this soil in mapping were areas of Cherryhill, Wind River, Van Horn, Frailey, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability unit IVe-1; Pine-Oak-Fescue range site.

Cherryhill Series

The Cherryhill series consists of well drained soils formed in old alluvium and the underlying colluvium weathered from consolidated and semiconsolidated tuffaceous sandstone on uplands. Slopes are 1 to 50 percent. Elevation is 500 to 1,200 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, shrubs, and ponderosa pine. The average annual precipitation is 14 to 20 inches, the average annual air temperature is 51° to 53° F, and the frost-free period is 140 to 180 days at 32° and 170 to 220 days at 28°.

In a representative profile the surface layer is very dark grayish brown silt loam about 11 inches thick. The upper 10 inches of the subsoil is dark brown silt loam and loam, and the lower 20 inches is dark yellowish brown heavy loam and sandy clay loam. Soft sandstone bedrock is at a depth of about 41 inches. The surface layer is slightly acid to neutral, and the subsoil is neutral to medium acid.

Permeability is moderately slow, and the available water capacity is 6.5 to 11 inches. Water-supplying capacity is 8 to 10 inches. Effective rooting depth is 40 to 60 inches.

These soils are used mostly for fruit orchards and some range and wildlife habitat.

Representative profile of Cherryhill silt loam, 1 to 7 percent slopes, 2 1/2 miles south of The Dalles city limits, 1,000 feet from Skyline road, 100 feet northeast of dirt road in the center of the line between sections 16 and 17, T. 1 N., R. 13 E.

Ap-0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry: weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine irregular pores; slightly acid; abrupt smooth boundary.

A12-6 to 11 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots many fine tubular pores; neutral; clear smooth boundary.

B11-11 to 17 inches dark brown (10YR 3/3) silt loam, brown (10YR 5/3) moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; few thin clay films in pores; few noncalcareous nodules 1/4 to 1 inch in diameter; neutral; clear smooth boundary.

B12-17 to 21 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine tubular pores; few thin clay films in pores; few coarse fragments; slightly acid; abrupt smooth boundary.

B21t-21 to 28 inches; dark yellowish brown (10YR 3/4) heavy loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; few roots; many fine tubular pores; common thick clay films on peels and in pores; medium acid; clear smooth boundary.

B22t-28 to 41 inches; dark yellowish brown (10YR 3/4) sandy clay loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; very hard, very firm, very sticky and very plastic; few roots; many fine tubular pores; many thick clay films on peds; medium acid; abrupt smooth boundary.

IIC-41 inches; weathered tuffaceous sandstone, cobbles, and rock fragments; few clay films on fractured surfaces.

The A horizon is grayish brown or brown dry and very dark grayish brown or dark brown when moist. It is silt loam or loam. The B horizon is brown, yellowish brown, or pale brown when dry. It is loam, sandy clay loam, or clay loam. Depth to rippable bedrock is 40 to 60 inches.

14B-Cherryhill silt loam, 1 to 7 percent slopes. A representative mapping unit is in the center of the line between sections 16 and 17, T. 1 N., R. 13 E. This soil is on ridgetops in long, broad areas. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Chenoweth, Hesslan, Van Horn, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-1; Pine-Oak-Fescue range site.

14C-Cherryhill silt loam, 7 to 12 percent slopes. A representative mapping unit is in the NE1/4SW1/4NW1/4 section 16, T. 1 N., R. 13 E. This soil is on ridgetops in long, broad areas.

Included with this soil in mapping were areas of Chenoweth, Hesslan, Van Horn, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is medium, and the hazard of erosion is mod-

erate. Capability unit IIIe-2; Pine-Oak-Fescue range site.

14D-Cherryhill silt loam, 12 to 20 percent slopes. A representative mapping unit is in the SE1/4SW1/4SW1/4 section 16, T. 1 N., R. 13 E. This soil is in irregularly shaped areas.

Included with this soil in mapping were areas of Chenoweth, Hesslan, Van Horn, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe-1; Pine-Oak-Fescue range site.

14E-Cherryhill silt loam, 20 to 35 percent slopes. A representative mapping unit is in the SW1/4SE1/4NW1/4 section 21, T. 1 N., R. 13 E. This soil is in long, irregularly shaped areas.

Included with this soil in mapping were areas of Chenoweth, Hesslan, Van Horn, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability unit IVe-1; Pine-Oak-Fescue range site.

14F-Cherryhill silt loam, 35 to 50 percent north slopes. A representative mapping unit is in the SW1/4NW1/4NE1/4 section 7, T. I N., R. 13 E. This soil is in long, irregularly shaped areas and has north-facing slopes. It has a profile similar to the one described as representative of the series, but it contains more rock fragments.

Included with this soil in mapping were areas of Chenoweth, Hesslan, Van Horn, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. This soil is used for range and wildlife habitat. Capability subclass IVe; Pine-Douglas Fir-Sedge range site.

15F-Cherryhill silt loam, 35 to 50 percent south slopes. A representative mapping unit is in the NE1/4NWl/4NE1/4 section 7, T. 1 N., R. 13 E. This soil is in long, irregularly shaped areas and has south-facing slopes. It has a profile similar to the one described as representative of the series, but it has a thinner, lighter colored surface layer and has more and larger rock fragments.

Included with this soil in mapping were areas of Chenoweth, Hesslan, Van Horn, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. This soil is used for range and wildlife habitat. Capability subclass VIe; Oak South Exposure range site.

16D-Cherryhill-Rock outcrop complex, 3 to 25 percent slopes. A representative mapping unit is in the NW1/4NE1/4SE1/4 section 9, T. 1 N., R. 13 E. This complex is about 50 to 85 percent a Cherryhill silt loam that has 3 to 25 percent slopes and 10 to 35 percent Rock outcrop. The Cherryhill soil has convex and concave slopes and is in upland between and around Rock outcrop. It has a profile similar to the one described as representative of the series, but it contains more rock fragments. Rock outcrop has convex and concave slopes and is in irregularly shaped areas of the uplands.

Included with this complex in mapping were areas of a soil similar to this Cherryhill soil, but it is 20 to 40 inches deep to bedrock and it makes up as much as 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. This complex is used for hay, pasture, and fruit orchards. Capability subclass VIe; Cherryhill soil in Pine-Oak-Fescue range site. Rock outcrop not in a range site.

Condon Series

The Condon series consists of well drained soils formed in loess and small amounts of volcanic ash over basalt bedrock on uplands. Slopes are I to 25 percent. Elevation is 1,600 to 3,600 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 45° to 52° F, and the frost-free period is 100 to 150 days at 32° and 150 to 200 days at 28°.

In a representative profile the surface layer is very dark brown silt loam about 13 inches thick. The upper 4 inches of the subsoil is very dark grayish brown silt loam, and the lower 10 inches is dark brown silt loam. Basalt bedrock is at a depth of about 27 inches. The soil material throughout the profile is neutral.

Permeability is moderate, and the available water capacity is 3 to 8 inches. Water-supplying capacity is 7 to 9 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

Representative profile of Condon silt loam, 1 to 7 percent slopes, 180 feet south of road in the NE1/4NWI/4NW1/4 section 28, T. 1 S., R. 15 E.:

Ap-0 to 9 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.

A12-9 to 13 inches; very dark brown (10YR 2/2) silt loam; grayish brown (10YR 5/2) dry; weak medium prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; neutral; clear smooth boundary.

B21-13 to 17 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear smooth boundary.

B22-17 to 22 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak medium prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine boon; many very fine tubular pores; neutral; clear wavy

B3-22 to 27 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 2 percent 2- to 5-millimeter and 1 percent 5-millimeter to 3-inch pebbles; neutral; abrupt wavy boundary.

IIR-27 inches; basalt bedrock.

The A horizon is grayish brown or dark grayish brown when dry and very dark brown or very dark grayish brown when moist. The B horizon is very dark grayish brown, dark grayish brown, or dark brown when moist. It is

silt loam and is 18 to 24 percent clay and is less than 15 percent coarser textured than very fine sand. Depth to bedrock is 20 to 40 inches.

17B-Condon silt loam, 1 to 7 percent slopes. A representative mapping unit is in the NE1/4NW1/4NW1/4, section 28, T. 1 S., R. 15 E. This soil is on ridgetops in long, broad areas. Slopes average about 5 percent. The soil has the profile described as representative of the series.

Included with this soil in mapping were areas of Bakeoven, Cantala, Lickskillet, and Wrentham soils. These soils make up about 10 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIe-5; Rolling Hills range site.

17C-Condon silt loam, 7 to 12 percent slopes. A representative mapping unit is in the NE1/4SW1/4NW1/4 section 28, T. 1 S., R. 15 E. This soil is on ridgetops in long, broad areas.

Included with this soil in mapping were areas of Bakeoven, Cantala, Lickskillet, and Wrentham soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-5; Rolling Hills range site.

17D-Condon silt loam, 12 to 25 percent slopes. A representative mapping unit is in the NWl/4SE1/4SW1/4 section 28, T. 1 S., R. 15 E. This soil is in long, broad areas.

Included with this soil in mapping were areas of Bakeoven, Cantala, Lickskillet, and Wrentham soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability subclass VIe; Rolling Hills range site.

18D-Condon-Bakeoven complex, 2 to 20 percent slopes. A representative mapping unit is in the SW1/4SWl/4SE1/4 section 25, T. I S., R. 15 E. This complex is about 50 to 85 percent a Condon silt loam and 10 to 35 percent a Bakeoven very cobbly loam. The London soil is on ridgetops or side slopes in circular or elongated mounds. The Bakeoven soil is on ridgetops or side slopes in areas of scabland between and around areas of the Condon soil.

Included with this complex in mapping were areas of Lickskillet very stony loam and other shallow stony soils. These soils make up as much as 15 percent of the unit.

Runoff is rapid, and the erosion hazard is moderate. This complex is used for range, hay, pasture, and wildlife habitat. Capability subclass VIe; London soil in Rolling Hills range site; Bakeoven soil in Scabland range site.

Cumulic Haplaquolls

19A-Cumulic Haplaquolls, nearly level. These soils are somewhat poorly drained or poorly drained silt loam, loam, sandy loam, clay loam, or clay. They formed in mixed alluvium along streams and on concave alluvial fans. The soils are in small, narrow, irregularly shaped areas along stream channels and in concave areas. Slopes are 0 to percent. Elevation is 100 to 1,000 feet. In uncultivated areas, the vegetation is sedges, bunchgrasses, shrubs, and forbs. The average annual precipitation is 15 to 30 inches, the average annual air temperature is 45° to 52° F, and the frost-free period is 100 to 180 days at 32° and 180 to 210 days at 28°.

The surface layer, subsoil, and substratum are generally dark colored. Mottling is at a depth of 10 to 40 inches. Water-rounded pebbles or cobbles commonly form a thin stone line or layer in the lower part of the subsoil. The surface layer, subsoil, and substratum range from slightly acid to medium acid.

Permeability is moderate to slow, and the available water capacity and water-supplying capacity are variable. Effective rooting depth is 20 to 60 inches or more.

These soils are used for hay, pasture, and wildlife habitat.

Runoff is slow, and the hazard of erosion is slight. The soils are subject to overflow and in places are ponded during high precipitation. Capability unit IVw-1.

Duart Series

The Duart series consists of well drained soils formed in a loess mantle that has an appreciable content of volcanic ash on uplands. Slopes are 1 to 55 percent. Elevation is 800 to 1,800 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 12 to 14 inches, the average annual air temperature is 48° to 50° F, and the frost-free period is 120 to 150 days at 32° and 150 to 200 days at 28°.

In a representative profile the surface layer is very dark grayish brown silt loam about 16 inches thick. The subsoil is brown silt loam about 17 inches thick. Semiconsolidated sandstone is at a depth of about 33 inches. The soil material throughout the profile is neutral.

Permeability is moderate, and the available water capacity is 3 to 8 inches. Water-supplying capacity is 7 to 9 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

Representative profile of Duart silt loam, 7 to 12 percent slopes, 190 feet north of road in the NW1/4NW1/4SWl/4 section 31, T. 1 N., R. 14 E.:

Ap-0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 3 percent rock fragments 2 millimeters to 1 inch in diameter; neutral; abrupt smooth boundary.

A12-8 to 16 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; percent rock fragments 2 millimeters to 1 inch in diameter; neutral; clear smooth boundary.

B21-16 to 26 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; about 2 percent rock fragments 2 millimeters to 1 inch in diameter; 5 percent non-

calcareous nodules 1/2 to 1 inch in diameter; neutral; clear smooth boundary.

B22-26 to 33 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; weak medium to fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; about 2 percent rock fragments 2 millimeters to 1 inch in diameter; 5 percent noncalcareous nodules 1/2 to 1 inch in diameter; neutral; clear wavy boundary.

IIC-33 to 39 inches; dark brown (10YR 3/3) semiconsolidated sandstone, pale brown (10YR 6/3) moist; extremely hard, extremely firm; no roots; few lime mycelia.

The A horizon is as much as 3 percent rock fragments 2 millimeters to 1 inch in size. The B horizon is dark brown or dark yellowish brown when moist. It is silt loam or loam. It is 16 to 18 percent clay, more than 15 percent particles coarser textured than very fine sand, and as much as 5 percent noncalcareous nodules 1/2 to 1 inch in diameter. Depth to rippable semiconsolidated sandstone is 20 to 40 inches.

20B-Duart silt loam, 1 to 7 percent slopes. A representative mapping unit is in the SE1/4SE1/4NE1/4 section 23, T. 1 N., R. 13 E. This soil is on ridgetops in long, broad areas. Slopes average about 5 percent.

Included with this soil in mapping were areas of Walla Walla, Dufur, and Skyline soils. These soils make up about 10 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIe-5; Rolling Hills range site.

20C-Duart silt loam, 7 to 12 percent slopes. A representative mapping unit is in the NW1/4NW1/4SW1/4 section 31, T. 1 N., R. 14 E. This soil is on ridgetops in long, irregularly shaped areas and has south-facing slopes. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Walla Walla, Dufur, and Skyline soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-5; Rolling Hills range site.

20D-Duart silt loam, 12 to 25 percent slopes. A representative mapping unit is in the SW1/4SE1/4NE1/4 section 36, T. 1 N., R. 13 E. This soil is in long, irregularly shaped areas and has south-facing slopes.

Included with this soil in mapping were areas of Walla Walla, Dufur, and Skyline soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability subclass VIe; Rolling Hills range site.

20E-Duart silt loam, 25 to 40 percent slopes. A representative mapping unit is in the SW1/4SE1/4NE1/4 section 24, T. 1 N., R. 13 E. This soil is in long, irregularly shaped areas and has south-facing slopes.

Included with this soil in mapping were areas of Walla Walla, Dufur, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIe; Droughty South Exposure range site.

21E-Duart complex, 20 to 55 percent slopes. A representative mapping unit is in the NW1/4NW1/4SE1/4 section 13, T. 1 S., R. 13 E. This complex is about 50 to 75 percent Duart silt loam, 25 to 40 percent slopes, and 20 to 35 percent shallow, very cobbly loam soils that have slopes of 20 to 55 percent. The Duart soil is on upland slopes between the very cobbly loam soils. The very cobbly loam soils are on upland slopes in long, irregularly shaped areas extending up and down the slope between the Duart soils.

Included with this complex in mapping were areas of moderately deep cobbly loam soils that make up about 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. This complex is used mainly for range, pasture, and wildlife habitat. Capability subclass VIe; Droughty South Exposure range site.

Dufur Series

The Dufur series consists of well drained soils formed in a loess mantle that has an appreciable content of volcanic ash over mixed alluvium and colluvium and sedimentary bedrock on uplands. Slopes are 1 to 40 percent. Elevation is 800 to 1,800 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 12 to 14 inches, the average annual air temperature is 48° to 50° F, and the frost-free period is 120 to 150 days at 32° and 150 to 200 days at 28°.

In a representative profile the surface layer is very dark brown silt loam about 8 inches thick. The subsoil is very dark grayish brown, dark brown, and dark yellowish brown silt loam about 34 inches thick. The substratum is yellowish brown cobbly fine sandy loam about 19 inches thick. Semiconsolidated sedimentary bedrock is at a depth of about 61 inches. The surface layer is slightly acid, the subsoil is neutral to mildly alkaline and the substratum is moderately alkaline.

Permeability is moderate, and the available water capacity is 6 to 12 inches. Water-supplying capacity is 9 to 12 inches. Effective rooting depth is 40 to 60 inches or more.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

Representative profile of Dufur silt loam, 1 to 7 percent slopes, 2 miles north of Dufur, 250 feet northeast of road on a broad ridgetop in the NWl/4SW1/4NW1/4 section 13, T. 1 S., R. 13 E.:

Apl-0 to 6 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very tine irregular pores; slightly acid; abrupt smooth boundary.

Ap2-6 to 8 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; moderate medium platy structure; hard, firm, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; slightly acid; clear smooth boundary.

B1-8 to 12 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, able, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; about 3 percent rock fragments 2 millimeters to 1 inch in diameter; 5 percent noncalcareous nodules 1/4 to 3/4 inch in diameter; neutral; clear wavy boundary.

B21-12 to 18 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 3 percent rock fragments 2 millimeters to 1 inch in diameter; 5 percent noncalcareous nodules 1/4 to 3/4 inch in diameter; neutral; gradual smooth boundary.

B22-18 to 32 inches; dark brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure; slightly hard, friable, slightly stick and slightly plastic; many very fine roots; many very fine tubular pores; about 5 percent rock fragments 2 millimeters to 1 inch in diameter 5 to 10 percent noncalcareous nodules 1/4 to 3/4 inch in diameter; mildly alkaline; gradual smooth boundary.

B3-32 to 42 inches; dark yellowish brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic many fine roots; common very fine tubular pores; 2 percent rock fragments 2 millimeters to 1 inch in diameter; 5 percent noncalcareous nodules 1/4 to 3/4 inch in diameter; mildly alkaline; clear smooth boundary.

IIClca-42 to 61 inches; yellowish brown (10YR 4/4) cobbly fine sandy loam light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic;common very fine roots; common very fine tubular pores; moderately calcareous; moderately alkaline; clear wavy boundary.

IIIC2-61 inches; semiconsolidated sedimentary bedrock.

The A horizon is very dark brown or very dark grayish brown when moist. It is silt loam or loam and is 0 to 5 percent rock fragments as much as 1 inch in diameter. The B horizon is silt loam or loam. It is 12 to 18 percent clay, 18 to 22 inches percent particles coarser textured than very fine sand, and 0 to 5 percent rock fragments as much as 1 inch in diameter. Secondary lime is at a depth of 30 to 43 inches. Depth to bedrock is 40 to more than 60 inches.

22B-Dufur silt loam, 1 to 7 percent slopes. A representative mapping unit is in the SW1/4NE1/4NE1/4 section 24, T. 1 S., R. 13 E. This soil is on ridgetops in long, broad areas. Slopes average about 5 percent. The soil has the profile described as representative of the series.

Included with this soil in mapping were areas of Walla Walla, Duart, Nansene, and Skyline soils. These soils make up about 10 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-3; Rolling Hills range site.

22C-Dufur silt loam, 7 to 12 percent slopes. A representative mapping unit is in the NW1/4SW1/4NW1/4 section 13, T. 1 S., R. 13 E. This soil is on ridgetops in long, broad areas.

Included with this soil in mapping were areas of Walla Walla, Duart, Nansene, and Skyline soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; Rolling Hills range site.

22D-Dufur silt loam, 12 to 25 percent slopes. A representative mapping unit is in the NW1/4NE1/4NE1/4 section 24, T. 1 S., R. 13 E. This soil is in long, broad, irregularly shaped areas.

Included with this soil in mapping were areas of Walla Walla, Duart, Nansene, and Skyline soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-4; Droughty North Exposure range site.

22E-Dufur silt loam, 25 to 40 percent slopes. A representative mapping unit is in the NEl/4NW1/4SW1/4 section 14, T. 1 S., R. 13 E. This soil is in long, irregularly shaped areas.

Included with this soil in mapping were areas of Walla Walla, Duart, Nansene, and Skyline soils. These soils make up about 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. This soil is used mainly for range, hay, pasture, and wildlife habitat. Capability unit IVe-2; North Exposure range site.

Dune Land

23-Dune land. A representative mapping unit is in the SWl/4SW1/4NE1/4 section 22, T. 2 N., R. 14 E. Dune land consists of small areas where the wind has drifted sand into dunes. Slopes range from 5 to 25 percent. This miscellaneous area is in the extreme northern part of the survey area. Dunes advance in the direction of the prevailing westerly wind and bury adjacent soils.

Dune land is nearly devoid of vegetation and is not suitable for grazing. Improved perennial grasses or nursery-grown plants or clones of Volga wildrye, planted 20 inches apart in rows spaced 20 inches apart, stabilize the dunes. Capability subclass VIIIe; not placed in a range site.

Endersby Series

The Endersby series consists of somewhat excessively drained soils formed in mixed alluvium, volcanic ash, and loess on bottom lands. Slopes are 0 to 3 percent. Elevation is 200 to 1,500 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 11 to 14 inches, the average annual air temperature is 49° to 53° F, and the frost-free period is 140 to 170 days at 32° and 170 to 200 days at 28°.

In a representative profile the surface layer is very dark grayish brown loam about 10 inches thick. The next layer is dark brown loam about 28 inches thick. Beneath this is dark brown fine sandy loam about 15 inches thick. Very gravelly sand is at a depth of about 53 inches. The material in the upper 24 inches is neutral, and is moderately alkaline in the lower 29 inches.

Permeability is moderately rapid, and the available water capacity is 6.5 to 11 inches. Water-supplying capacity is 9 to 12 inches. Effective rooting depth is 40 to 60 inches.

These soils are used for small grain, hay, pasture, range, and wildlife habitat.

Representative profile of Endersby loam, 150 feet south of Fifteen Mile Road in the SWl/4NE1/4SW1/4 section 25, T. 2 N., R. 14 E.:

Ap1-0 to 2 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/ 2) dry; weak thin

platy structure; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.

Ap2-2 to 10 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; neutral; abrupt wavy boundary.

AC-10 to 24 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic, few very fine roots; many very fine tubular pores; neutral; clear wavy bounds

C1-24 to 38 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; moderately alkaline; clear wavy boundary.

C2-38 to 53 inches dark brown (10YR 3/3) fine sandy loam, brown (10YR 5/3) dry; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; moderately alkaline; clear wavy boundary.

IIC3-53 to 60 inches; multicolored very gravelly sand; single grained; loose, nonsticky and nonplastic.

The A horizon is gray, grayish brown, dark gray, or dark grayish brown when dry and very dark gray, very dark grayish brown, or dark brown when moist. It is loam or fine sandy loam. It has weak fine angular or platy structure or is structureless. The AC horizon and Cl horizon are stratified in places with thin lenses ranging from silt to loamy sand. The content of pebbles in the upper 40 inches ranges from 0 to 15 percent. The content of rock fragments below a depth of 40 inches ranges from 50 to 80 percent.

24-Endersby loam. A representative mapping unit is in the SW1/4NE1/4SW1/4 section 25, T. 2 N., R. 14 E. This soil has slopes of 0 to 3 percent and is on alluvial bottoms in long, narrow areas.

Included with this soil in mapping were areas of Hermiston, Pedigo, and Tygh soils. These soils make up about 15 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-3, nonirrigated and I-1, irrigated; Semi-Moist Bottom range site.

Frailey Series

The Frailey series consists of well drained soils formed in volcanic ash, loess, and colluvium weathered from semiconsolidated sedimentary materials on uplands. Slopes are 3 to 70 percent. Elevation is 1,000 to 3,500 feet. The vegetation is oak, ponderosa pine, Douglas-fir, bunchgrasses, forbs, and shrubs. The average annual precipitation is 16 to 30 inches, the average annual air temperature is 45° to 49° F, and the frost-free period is 100 to 140 days at 32° and 120 to 160 days at 28°.

In a representative profile the surface layer is very dark grayish brown loam about 4 inches thick. The subsoil is dark brown loam about 46 inches thick. The substratum is brown loam about 15 inches thick. The soil material throughout the profile is slightly acid.

Permeability is moderate, and the available water capacity is 5 to 10 inches. Water-supplying capacity is 10 to 15 inches. Effective rooting depth is 40 to 6 inches or more.

These soils are used for timber, range, wildlife habitat, and water supply.

Representative profile of Frailey loam, 30 to 70 percent slopes, about 50 feet north of road in the NE1/4NE1/4SW1/4, section 22, T. 2 N., R. 11 E.:

O1-2 inches to 0; fir needles, twigs, and partly decomposed material.

A1-0 to 4 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; may very fine irregular pores; 15 percent fine pebbles; slightly acid; clear smooth boundary.

B21-4 to 10 inches; dark brown (10YR 3/3) loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky and weak fine granular structure; slightly hard, friable, slightly stick and slightly plastic; many very fine roots many very fine tubular pores 1 percent fine pebbles; slightly acid; clear smooth boundary.

B22-10 to 33 inches; dark brown (10YR 3/3) loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; 10 percent fine pebbles 5 percent cobbles; slightly acid; clear smooth boundary.

B23-33 to 50 inches; dark brown (10YR 3/3) loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine and medium roots; many very fine tubular pores; 10 percent cobbles, 5 percent pebbles; few thin clay films in pores; slightly acid; clear smooth boundary.

C-50 to 65 inches; brown (10YR 4/3) loam, light brownish gray (10YR 6/2) dry; massive; hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few very fine tubular pores; 10 percent cobbles, 5 percent pebbles; few thin clay films in pores; slightly acid. The A horizon is grayish brown or light brownish gray whendry and very dark grayish brown or dark brown when moist. The B horizon is loam. It is 5 to 20 percent rock fragments 2 millimeters to 3 inches in size and 0 to 15 percent cobbles. Depth to rippable bedrock is 40 to 60 inches or more.

25E-Frailey loam, 3 to 30 percent slopes. A representative mapping unit is in the NE1/4NE1/4NE1/4 section 7, T. 2 S., R. 12 E. This soil is in broad, irregularly shaped areas.

Included with this soil in mapping were areas of Hesslan, Ketchly, Skyline, and Wamic soils. These soils make up as much as 20 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability subclass VIe; Pine-Douglas-Fir Sedge range site; woodland group 3o.

25F-Frailey loam, 30 to 70 percent slopes. A representative mapping unit is in the NE1/4NE1/4SW1/4 section 22, T. 2 N., R. 11 E. This soil is in long, narrow areas and has north-facing slopes. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Hesslan, Ketchly, Skyline, and Wamic soils. These soils make up as much as 20 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIe ; woodland group 3r.

Hermiston Series

The Hermiston series consists of well drained soils formed in alluvium derived from loess and volcanic ash on bottom lands. Slopes are 0 to 3 percent. Elevation is 800 to 2,600 feet. In uncultivated areas, the

vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 49° to 54° F, and the frost-free period is 130 to 180 days at 32° and 180 to 200 days at 28°.

In a representative profile the surface layer is very dark grayish brown silt loam about 16 inches thick. The underlying material is very dark grayish brown and dark brown silt loam that extends to a depth of 60 inches or more. Depth to gravel and sand is 40 to 60 inches or more. The soil material throughout the profile is neutral to moderately alkaline.

Permeability is moderate, and the available water capacity is 7.5 to 12.5 inches. Water-supplying capacity is 8 to 13 inches. Effective rooting depth is 40 to 60 inches or more.

These soils are used for hay, pasture, small grain, range, and wildlife habitat.

Representative profile of a Hermiston silt loam in the SW1/4SE1/4NW1/4, section 32, T. 2 N., R. 15 E.:

Ap-0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; neutral; gradual wavy boundary.

A12-8 to 16 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; gradual wavy boundary.

AC-16 to 37 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure; slightly hard, firm, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; moderately calcareous; moderately alkaline; gradual wavy boundary.

C1ca-37 to 48 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; moderately calcareous with mycelial lime; mildly alkaline; gradual wavy boundary.

C2-48 to 60 inches; dark brown (10YR 3/3) silt loam, grayish brown (10YR 5/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; neutral; abrupt smooth boundary.

The A horizon is dark grayish brown or grayish brown when dry and very dark brown or very dark grayish brown when moist. It is silt loam or loam. The C horizon is grayish brown or brown when dry and very dark grayish brown or dark brown when moist. It is silt loam or loam and has stratified layers of sand and gravel.

26-Hermiston silt loam. A representative mapping unit is in the SW1/4SE1/4NW1/4 section 32, T. 2 N., R. 15 E. This soil has slopes of 0 to 3 percent. It is, adjacent to streams in long, narrow strips that average about 100 yards wide.

Included with this soil in mapping were areas of Tygh, Endersby, Pedigo, and noncalcareous silt loam soils. These soils make up about 10 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-3, nonirrigated and I-l, irrigated-, Semi-Moist Bottom range site.

Hesslan Series

The Hesslan series consists of well drained soils formed in loess, volcanic ash, and colluvium weathered from sandstone on uplands. Slopes are 5 to 70 percent. Elevation is 500 to 3,500 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, shrubs, oak, and ponderosa pine. The average annual precipitation is 14 to 20 inches, the average annual air temperature is 45° to 49° F, and the frost-free period is 110 to 140 days at 32° and 140 to 160 days at 28°.

In a representative profile the surface layer is very dark grayish brown stony loam about 9 inches thick. The upper 9 inches of the subsoil is dark brown loam, and the lower 5 inches is dark brown cobbly loam. Semiconsolidated sandstone is at a depth of about 23 inches. The soil material throughout the profile is neutral.

Permeability is moderate, and the available water capacity is 3 to 8 inches. Water-supplying capacity is 5 to 7 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for range, timber, wildlife habitat, and water supply.

Representative profile of a Hesslan stony loam in an area of Skyline-Hesslan complex, 40 to 65 percent slopes, 500 feet north of the county road in the NWl/4SW1/4SE1/4 section 1, T. 1 S., R. 12 E.:

A11-0 to 3 inches; very dark grayish brown (10YR 3/2) stony loam, grayish brown (10YR 5/2) dry; weak medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 5 percent pebbles, 5 percent cobbles, and 5 percent stones; neutral; abrupt smooth boundary.

A12-3 to inches; very dark grayish brown (10YR 3/2) stony loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 5 percent pebbles, 5 percent cobbles, and 5 percent stones; neutral; abrupt smooth boundary.

B1-9 to 18 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak medium sub angular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; many very tine tubular pores; 5 percent pebbles and 5 percent cobbles; neutral; clear smooth boundary.

B2-18 to 23 inches; dark brown (10YR 4/3) cobbly loam, pale brown (10YR 6/3) dry weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 10 percent pebbles and 10 percent cobbles; neutral; abrupt wavy boundary.

IIC-23 to 30 inches; semiconsolidated sandstone; extremely hard.

The A horizon is grayish brown, dark grayish brown, or brown when dry and very dark grayish brown, very dark brown, or dark brown when moist. It is stony loam or cobbly loam. The content of rock fragments 2 millimeters to 10 inches in size ranges from 5 to 20 percent. The content of surface stones is 5 to 20 percent. The B horizon is grayish brown, brown, or pale brown when dry and very dark grayish brown or dark brown when moist. It is 5 to 30 percent rock fragments 2 millimeters to 10 inches in size. It has weak or moderate medium and fine subangular blocky structure. Depth to rippable bedrock is 20 to 40 inches.

27F-Hesslan complex, 30 to 70 percent slopes.

A representative mapping unit is in the SW1/4NW1/4NW1/4 section 17, T. 1 S., R. 13 E. This complex is about 60 percent a Hesslan stony loam and 20 percent loam or cobbly loam soils that are 40 to 60 inches deep to bedrock. The Hesslan soil is on ridgetops and north-facing side slopes.

Included with this complex in mapping were areas of Wamic loam and Skyline very cobbly loam. These soils make up about 20 percent of the unit. Also included were outcroppings of sandstone.

Runoff is rapid, and the hazard of erosion is severe. This complex is used for timber, range, wildlife habitat, and water supply. Capability subclass VIIs; Oak Steep North range site.

28E-Hesslan-Skyline complex, 5 to 40 percent slopes. A representative mapping unit is in the SW1/4SW1/4NW1/4 section 5, T. 1 S., R. 12 E. This complex is about 30 to 60 percent a Hesslan stony loam and 20 to 50 percent a Skyline very cobbly loam. The Hesslan soil has north-facing slopes, and the Skyline soil has south-facing slopes.

Included with this complex in mapping were areas of Frailey loam and Wamic loam. These soils make up about 20 percent of the unit.

Runoff is medium to rapid, and the hazard of erosion is moderate. This complex is used for range, wildlife habitat, and water supply. Capability subclass VIIs; Oak Steep South range site.

Ketchly Series

The Ketchly series consists of well drained soils formed in loess, volcanic ash, and colluvium weathered from andesite on uplands. Slopes are 3 to 65 percent. Elevation is 2,000 to 3,600 feet. The vegetation includes Douglas-fir, ponderosa pine, Oregon white oak, bunchgrasses, forbs, and shrubs. The average annual precipitation is 25 to 30 inches, the average annual air temperature is 42° to 45° F, and the frost-free period is 70 to 120 days at 32° and 100 to 140 days at 28°.

In a representative profile the surface layer is very dark grayish brown or dark brown loam about 11 inches thick. The subsoil is brown heavy loam about 31 inches thick. The substratum is very cobbly clay loam about 3 inches thick. Andesite bedrock is at a depth of 45 inches.

Permeability is moderately slow, and the available water capacity is 6 to 11 inches. Water-supplying capacity is 10 to 15 inches. Effective rooting depth is 40 to 60 inches.

These soils are used for timber, water supply, and wildlife habitat.

Representative profile of Ketchly loam, 3 to 30 percent slopes, 175 feet south of road in the NE1/4NE1/4NW1/4 section 2, T. 1 N., R. 11 E.:

O1-1 inch to 0; fir needles and twigs, grass, and deciduous leaves.

All-0 to 6 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard friable, slightly sticky and slightly plastic; many very tine and fine roots; many very fine irregular pores; 15 percent pebbles 1/8 to 1/2 inch in diameter; neutral; gradual smooth boundary.

A12-6 to 11 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry, weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine and medium roots; many very fine tubular pores; 15 percent pebbles 1/4 to 1/2 inch in diameter; neutral; clear smooth boundary.

Bl-11 to 18 inches; brown (7.5YR 4/4) heavy loam, pale brown (10YR 6/ 3) dry weak medium subangular blocky structure; hard, liable, slightly sticky and slightly plastic; many fine and medium roots; many very fine tubular pores; 15 percent pebbles; neutral; gradual smooth boundary.

B21t-18 to 24 inches; brown (7.5YR 4/4) heavy loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure very hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; common thin clay films in pores; neutral; gradual smooth boundary

B22t-24 to 42 inches; brown (7.5YR 4/4) heavy loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; extremely hard, firm, sticky and plastic; few to common fine and medium roots; many very fine tubular pores; common thin clay films on peds and in pores; slightly acid; gradual wavy boundary.

IIC-42 to 45 inches; very cobbly clay loam; massive; extremely hard, very firm, sticky and plastic; common very fine pores.

IIIR-45 inches; andesite bedrock.

The B2t horizon is loam, heavy loam, or light clay loam and is 5 to 30 percent rock fragments. Depth to bedrock is 40 to 60 inches or more.

29E-Ketchly loam, 3 to 30 percent slopes. A representative mapping unit is in the NE1/4NE1/4NW1/4 section 2, T. 1 N., R. 14 E. This soil is on broad ridgetops. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Bins, Bindle, Frailey, Bald, and shallow stony loam soils. These soils make up as much as 15 percent of the unit.

Runoff is slow, and the hazard of erosion is moderate. Capability subclass VIe; woodland group 2o.

29F-Ketchly loam, 30 to 65 percent slopes. A representative mapping unit is in the NW1/4NE1/4 section 10, T. 1 N., R. 11 E. This soil has long and narrow slopes.

Included with this soil in mapping were areas of Bins, Bindle, and Bald soils. These soils make up as much as 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIe; woodland group 2r.

Licksillet Series

The Lickskillet series consists of well drained soils formed in shallow, stony colluvium consisting of a mixture of loess, rock fragments, and residuum weathered from the underlying basalt on uplands. Slopes are 15 to 70 percent. Elevation is 200 to 3,600 feet. The vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 45° to 52° F, and the frost-free period is 100 to 150 days at 32° and 150 to 210 days at 28 .

In a representative profile (fig. 4) the surface layer is very dark grayish brown extremely stony loam about

Figure 4: Profile of Lickskillet very stony loam, 15 to 40 percent slopes, which Is underlain by bedrock at a depth of 12 inches.

4 inches thick. The upper 6 inches of the subsoil is dark brown very stony heavy loam, and the lower 6 inches is dark yellowish brown very gravelly heavy loam. Basalt bedrock is at a depth of about 16 inches. The surface layer is slightly acid, and the subsoil is neutral.

Permeability is moderate, and the available water capacity is 1 to 3 inches. Water-supplying capacity is 2 to 5 inches. Effective rooting depth is 12 to 20 inches.

These soils are used for range, wildlife habitat, and water supply.

Representative profile of Lickskillet extremely stony loam, 40 to 70 percent slopes, in the SE1/4NE1/4SW1/4, section 27, T. 2 S., R. 15 E.

A1--0 to 4 inches; very dark grayish brown (10YR 3/2) extremely stony loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak fine granular; slightly hard, friable, slight sticky and slightly plastic; many very fine roots; many very me irregular pores; 2 percent basalt pebbles; 10 percent cobbles and 25 percent stones; slightly acid; abrupt smooth boundary.

B1-4 to 10 inches; dark brown (10YR 3/3) very stony heavy loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; many very fine roots; many very fine tubular pores; 30 percent basalt pebbles, 10 percent cobbles, and 20 percent stones; neutral; abrupt smooth boundary.

B2-10 to 16 inches; dark yellowish brown (10YR 3/4) very gravelly heavy loam, yellowish brown (10YR 5/4) dry; we medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores; 40 percent basalt pebbles and 25 percent cobbles and stones; neutral; abrupt wavy boundary.

IIR-16 inches; basalt bedrock.

The A horizon is very dark brown, very dark grayish brown or dark brown when moist. It is loam, silt loam, or very fine sandy loam. In some places it is gravelly, very gravelly, cobbly, or very cobbly, and in others it is stony, very stony, or extremely stony. The B horizon is heavy silt loam, heavy loam, sandy clay loam, silty clay loam, or clay loam. In places clay films are in pores and some basalt fragments and extend into fractures in the bedrock. Depth to basalt bedrock is 12 to 20 inches.

30E-Lickskillet very stony loam, 15 to 40 percent slopes. A representative ma ping unit is in the SE1/4NE1/4NE1/4 section 28, T. 2 S., R. 15 E. This soil is in broad, irregularly shaped areas and has south-facing slopes. It has a profile similar to the one described as representative of the series, but the surface layer contains fewer stones.

Included with this soil in mapping were areas of Bakeoven, Condon, Walla Walla, and Wrentham soils. These soils make up as much as 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIs; Droughty South Exposure range site.

31F-Lickskillet extremely stony loam, 40 to 70 percent slopes. A representative mapping unit is in the SE1/4NE1/4SW1/4 section 27, T. 2 S., R. 15 E. This soil is in long, broad, irregularly shaped areas and has south-facing slopes. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Bakeoven, Condon, Walla Walla, and Wrentham soils. These soils make up as much as 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIs; Droughty Steep South range site.

Maupin Series

The Maupin series consists of well drained soils formed in loess and volcanic ash on uplands. Slopes are 0 to 12 percent. Elevation is 1,600 to 3,400 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 45° to 52° F, and the frost-free period is 120 to 170 days at 32° and 170 to 200 days at 28°.

In a representative profile the surface layer is very dark grayish brown loam about 10 inches thick. The subsoil is dark brown loam about 15 inches thick. The upper 6 inches of the substratum is dark brown loam. An indurated hardpan is at a depth of about 31 inches.

The surface layer is neutral and the subsoil is neutral to mildly alkaline.

Permeability is moderate, and the available water capacity is 3 to 7 inches. Water-supplying capacity is 7.5 to 8.5 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for dryfarmed small grain, hay, pasture, irrigated crops, range, and wildlife habitat.

Representative profile of Maupin loam, 0 to 5 percent slopes, 35 feet south of State Highway 216 in the NW1/4SW1/4SW1/4 section 2, T. 5 S., R. 13 E.:

Ap1-0 to 6 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.

Ap2-6 to 10 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; abrupt smooth boundary.

B2-10 to 20 inches dark brown (10YR 3/3) loam, pale brown (10YR 6/3) dry; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; many very fine roots; many very fine tubular pores; few nodules; neutral; abrupt wavy boundary.

B3ca-20 to 25 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; man very fine tubular pores; few nodules; lime in mycelium farm; weakly calcareous; mildly alkaline; clear wavy boundary.

C1ca-25 to 31 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; massive; hard, friable, slightly plastic; many very fine tubular pores; common nodules; 5 percent fragments 2 millimeters to 3 inches in size; lime in mycelium form; moderately calcareous; moderately alkaline; abrupt wavy boundary.

Csicam-31 to 37 inches; dark brown (10YR 4/3) and pale brown (10YR 6/3) dry duripan; platy; very firm; indurated silica laminar capping nearly continuous; strongly calcareous.

IIR-37 inches; fractured bedrock.

The A horizon is very dark grayish brown or dark brown when moist. The B horizon is brown or pale brown when dry. The C1 horizon is brown or pale brown when dry. The control section is 18 to 22 percent clay, is more than 15 percent material coarser textured than very fine sand, and is 2 to 5 percent fragments 2 millimeters to 3 inches in diameter. Depth to the hardpan is 20 to 40 inches, and depth to bedrock is 22 to 45 inches.

32A-Maupin loam, 0 to 5 percent slopes. A representative mapping unit is in the NW1/4SW1/4SW1/4 section 2, T. 5 S., R. 13 E. This soil is on ridgetops in long, broad, narrow areas. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Bakeoven soils and Maupin variant soils that have 0 to 3 percent slopes. These soils make up about 10 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-3, nonirrigated and IIe-2, irrigated; Shrubby Rolling Hills range site.

32B-Maupin loam, 5 to 12 percent slopes. A representative mapping unit is in the NW1/4SE1/4NEl/4 section 18, T. 4 S., R. 14 E. This soil is on ridgetops in long, broad, narrow areas.

Included with this soil in mapping were areas of soils covered with 15 to 50 percent stones and boulders. These soils make up less than 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-5; Shrubby Rolling Hills range site.

Maupin Variant

The Maupin variant consists of well drained soils formed in loess and volcanic ash on uplands. Slopes are 0 to 3 percent. Elevation is 1,600 to 3,400 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 45° to 52° F, and the frost-free period is 120 to 170 days at 32° and 170 to 200 days at 28°.

In a representative profile the surface layer is very dark grayish brown loam about 10 inches thick. The subsoil is dark brown and brown loam about 25 inches thick. The substratum is dark brown loam about 16 inches thick. Basalt bedrock is at a depth of about 51 inches. The surface layer is neutral and the subsoil is neutral to moderately alkaline.

Permeability is moderate, and the available water capacity is 6 to 12 inches. Water-supplying capacity is 7.5 to 10 inches. Effective rooting depth is 40 to 60 inches or more.

This soil is used for dryfarmed small grain, hay, pasture, irrigated crops, range, and wildlife habitat.

Representative profile of Maupin variant loam, 50 feet north of State Highway 216 in the NW1/4NE1/4SW1/4 section 9, T. 4 S., R. 13 E.

Ap1-0 to 4 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; abrupt smooth boundary.

Ap2-4 to 10 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; abrupt smooth boundary.

B2-10 to 20 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 10 percent round nodules; neutral; abrupt wavy boundary.

B3ca-20 to 35 inches; brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; weak medium subangular block structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 10 percent nodules; moderately calcareous; moderately alkaline; clear wavy

Clca-35 to 43 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 10 percent nodules; moderately calcareous; moderately alkaline; abrupt wavy boundary.

C2sica-43 to 51 inches; dark brown (10YR 3/3) loam, pale brown (10YR 6/3) dry; massive; weakly cemented; very hard, firm, slightly sticky and slightly

plastic; few very fine roots; many very fine tubular pores; 10 percent nodules; strongly calcareous; moderately alkaline; abrupt wavy boundary.

IIR-51 inches; basalt bedrock with a thin indurated capping.

The A horizon is loam or silt loam. The B horizon is loam or heavy loam. Depth to bedrock is 40 to 60 inches or more.

33-Maupin variant loam. A representative mapping unit is in the NW1/4NE1/4SW1/4 section 9, T. 4 S., R. 13 E. This soil is on uplands. Slopes average about 2 percent.

Included with this soil in mapping were areas of Maupin and Bakeoven soils. These soils make up about 10 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-3, nonirrigated and IIe-2, irrigated; Shrubby Rolling Hills range site.

Nansene Series

The Nansene series consists of well drained soils formed in loess on uplands. Slopes are 35 to 70 percent. Elevation is 300 to 1,500 feet. The vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 11 to 13 inches, the average annual air temperature is 48° to 52° F, and the frost-free period is 140 to 170 days at 32° and 170 to 200 days at 28 .

In a representative profile the surface layer is very dark brown silt loam about 22 inches thick. The subsoil is dark brown silt loam about 10 inches thick. The upper 20 inches of the substratum is dark brown silt loam, and the lower 10 inches is grayish brown silt loam. Basalt bedrock is at a depth of about 62 inches. The surface layer and subsoil are neutral, and the substratum is neutral to moderately alkaline.

Permeability is moderate, and the available water capacity is 6 to 11 inches. Water-supplying capacity is 8 to 12 inches. Effective rooting depth is 40 to 60 inches or more.

These soils are used for range and wildlife habitat.

Representative profile of Nansene silt loam, 35 to 70 percent slopes, in NW1/4NW1/4NE1/4 section 29, T. 1 N., R. 15 E.

A11-0 to 4 inches; very dark brown (10YR 2/2) coarse silt loam, dark grayish brown (10YR 4/2) dry; weak thin platy structure parting to weak fine granular; slightly hard, very friable, slightly sticky and slightly, plastic; many very fine roots; many very fine irregular pores; neutral; clear smooth boundary.

A12-4 to 14 inches; very dark brown (10YR 2/2) coarse silt loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; neutral; clear smooth boundary.

A13-14 to 22 inches; very dark brown (10YR 2/2) coarse silt loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common fine to medium tubular pores; neutral; gradual smooth boundary.

B2-22 to 82 inches; dark brown (10YR 3/3) coarse silt loam, dark brown (10YR 4/8) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; neutral ; gradual smooth boundary.

C1-32 to 52 inches; dark brown. (10YR 3/8) coarse silt loam, brown (10YR 5/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine tubular pores; neutral; gradual smooth boundary.

C2ca-52 to 62 inches; grayish brown (10YR 5/2) silt loam, light brownish gray (106/2) moist; massive; slightly hard to hard, friable, slightly sticky and slightly plastic; few very fine roots; 5 percent fragments 1/16 inch in diameter; calcareous nodules; moderately calcareous; disseminated and segregated lime; moderately alkaline.

IIR-62 inches; basalt bedrock.

The A horizon is dark grayish brown or dark brown when dry. The B horizon is dark brown or dark grayish brown when dry and moist. The C horizon is dark brown to grayish brown when moist. Clay content of the soil is 10 to 18 percent. The soil is less than 5 percent fragments 1 inch or less in diameter. Rock is exposed on as much as 10 percent of the surface layer in places. Depth to basalt bedrock is 40 to 60 inches or more.

34F-Nansene silt loam, 35 to 70 percent slopes

A representative mapping unit is in the NW1/4NW1/4NE1/4, section 29, T. 1 N., R. 15 E. This soil is in long, narrow areas and has north-facing slopes.

Included with this soil in mapping are areas of Walla Walla, Lickskillet, and Wrentham soils and Rock outcrop that make up as much as 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIe; Steep North range site.

Pedigo Series

The Pedigo series consists of somewhat poorly drained soils formed in alluvium derived from loess and volcanic ash on bottom lands. Slopes are 0 to 3 percent. Elevation is 200 to 2,700 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 50° to 53° F, and the frost-free period is 130 to 180 days at 32° and 180 to 200 days at 28°.

In a representative profile the surface and subsurface layers are black silt loam to a depth of 40 inches. The upper 9 inches of the underlying material is very dark gray silt loam, and below this is dark grayish brown loam to a depth of 60 inches or more. The soil material in the profile is moderately alkaline to neutral.

Permeability is moderate, and the available water capacity is 10 to 11 inches. Water-supplying capacity is 9 to 13 inches. Effective rooting depth is more than 60 inches.

These soils are used for hay, pasture, dryfarmed small grain, range, and wildlife habitat.

Representative profile of Pedigo silt loam in the SE1/4NW1/4 section 21, T. 1 S., R. 13 E.:

Ap-0 to 8 inches; black (10YR 2/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; moderately calcareous; moderately alkaline; abrupt smooth boundary.

A12-8 to 21 inches; black (10YR 2/1) silt loam, dark grayish brown (10YR 4/2) dry; weak coarse structure; slightly hard, friable, slightly sticky and slightly plastic; many very tine roots; many fine tubular pores; weakly calcareous; moderately alkaline; abrupt smooth boundary.

AC-21 to 40 inches; black (10YR 2/1) silt loam, yellowish brown (l0YR 5/2) dry; massive; hard, friable, slight sticky and slightly plastic; many very fine roots; many fine tubular pores; neutral; clear smooth boundary.

C1-40 to 49 inches; very dark gray (10YR 3/1) silt loam, light brownish gray (10YR 6/2) y; massive; hard, friable, slightly sticky and slightly plastic' few roots; many fine and few medium tubular pores; neutral; clear smooth boundary.

C2-49 to 60 inches; dark grayish brown (10YR 4/2) loam; massive; hard, friable, slightly sticky and slightly plastic; few roots; many fine and few medium tubular pores; neutral.

The A horizon is dark grayish brown or dark brown when dry and very dark brown, dark grayish brown, black, or very dark grayish brown when moist. It is silt loam, coarse silt loam, or loam and is moderately calcareous to strongly calcareous. The AC horizon is light gray, light brownish gray, or grayish brown when dry and very dark gray, very dark grayish brown, or black when moist. It is coarse silt loam, silt loam, or silty clay loam.

35-Pedigo silt loam. A representative mapping unit is in the SE1/4NW1/4 section 21, T. 1 S., R. 13 E. This soil is in long, narrow areas on alluvial bottom lands adjacent to streams. Slopes are 0 to 3 percent.

Included with this soil in mapping are areas of Hermiston, Endersby, and Tygh soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIw-1; Alkaline Bottom range site.

Quincy Series

The Quincy series consists of soils formed in sandy alluvium from mixed material on bottom lands. Slopes are 0 to 3 percent. Elevation is 1,400 to 1,500 feet. In uncultivated areas, the vegetation is cottonwoods, forbs, and shrubs. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 48° to 52° F, and the frost-free period is 120 to 170 days at 32° and 170 to 200 days at 28°.

In a representative profile the surface layer is very dark gray loamy fine sand about 6 inches thick. The underlying material to a depth of 35 inches is very dark grayish brown sand, the next 9 inches is dark gray fine sand, and below this to a depth of 60 inches or more is dark gray very fine sand. The surface layer is medium acid, and the underlying material is slightly acid to neutral.

Permeability is rapid, and the available water capacity is 3 to 6 inches. Water-supplying water-supplying capacity is variable and depends upon the depth to the water table. Effective rooting depth is 40 to 60 inches.

This soil is used for irrigated hay and pasture, crops, range, and wildlife habitat.

Representative profile of Quincy loamy fine sand, wet, in the NW1/4SW1/4NW1/4, section 12, T. 4 S., R. 13 E.

Ap-0 to 6 inches; very dark gray (10YR 3/1) loamy fine sand, gray (10YR 5/1) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

C1-6 to 41 inches; very dark grayish brown (10YR 3/2) sand, grayish brown (10YR 5/2) dry; single grained; loose; many very fine roots; 10 percent very fine pebbles; slightly acid; clear wavy boundary.

C2-41 to 50 inches; dark gray (10YR 4/1) fine sand, gray (10YR 5/1) dry; single grained; loose; common fine roots; common dark brown (7.5YR 4/4) moist, mottles; slightly acid; clear wavy boundary.

C3-50 to 60 inches; dark gray (10YR 4/1) very fine sand, gray (10YR 6/1) dry; single grained; loose; very few roots; neutral.

The A horizon is gray or grayish brown when dry and very dark gray or very dark grayish brown when moist. It is loamy fine sand or loamy sand and is as much as 20 percent coarse fragments 2 to 10 millimeters in size. The C1 horizon is gray to grayish brown when dry. It is loamy sand or sand and is 10 to 20 percent pebbles. The C2 horizon is gray or light gray when dry and has common to many dark brown mottles. It is sand or very fine sand.

Quincy soils are excessively drained or somewhat excessively drained. However, this Quincy soil is on bottom land and remains wetter throughout the year than is normal for the Quincy series because of a water table at a depth of 40 to 60 inches.

36-Quincy loamy fine sand, wet. A representative mapping unit is in the NW1/4SW1/4NWI/4 section 12, T. 4 S., R. 13 E. This soil is on bottom lands along major streams. Slopes are 0 to 3 percent.

included with this soil in mapping were areas of Endersby, Tygh, and Pedigo soils. These soils make up as much as 10 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Depth to a water table is 40 to 60 inches in spring and early in summer. Some areas are subject to overflow. Capability unit IIIw-1; Semi-Moist Bottom range site.

Riverwash

37--Riverwash. A representative mapping unit is in the NE1/4SW1/4NW1/4 section 11, T. 4 S., R. 13 E. Riverwash is in narrow, irregularly shaped strips in the bends of stream channels along the Columbia and Deschutes Rivers and along drainageways in the survey area. It is 2 to 10 feet above the normal waterline. The strips are 40 to 200 yards wide. Riverwash consists of well-rounded sand, gravel, stones and boulders, chiefly basalt. The surface layer generally is uneven. This area has little or no vegetation.

Riverwash is subject to overflow when the water is high and is extremely droughty when the water is low. During each overflow, new deposits are received and some material is removed. Adjacent river sandbars are included in the unit.

Riverwash is used for wildlife habitat and as a source of sand and gravel. Capability subclass VIIIw; not placed in a range site.

Rock Outcrop

38-Rock outcrop-Rubble land complex. A representative mapping unit is in the NWl/4NE1/4, section 17, T. 3 S., R. 15 E. This complex is about 65 to 75 percent Rock outcrop and 20 to 30 percent Rubble land. It is on uplands in basalt outcrop and rubble (fig. 5) . Elevation is 200 to 3,600 feet. Rock outcrop-Rubble land complex has little or no vegetation except on included soils. The average annual precipitation is 10 to 22 inches, the average annual air temperature is 45° to 52° F, and the frost-free period is 70 to 210 days.

Figure 5: Area of Rock outcrop-Rubble land complex. Slopes are 30 to 100 percent.

This complex is severely eroded. The almost perpendicular basalt cliffs are as much as 500 feet high and have stony or bouldery foot slopes. Slopes are 30 to 100 percent.

Included with this complex in mapping were areas of Wrentham, Nansene, Lickskillet, and Wyeth soils. These soils make up as much as 15 percent of the unit.

This complex is used mainly for wildlife habitat and water supply. Capability subclass VIIIs; not placed in a range site.

39-Rock outcrop-Xeropsamments complex. A representative mapping unit is in the NW1/4NW1/4SW1/4 section 2, T. 2 N., R. 11 E. This complex is along the Columbia River. These areas were previously part of the Columbia River channel but are now terraces above the river. Stream action has scoured holes in the basalt lava beds and deposited sand and water-worn gravel. Numerous large and small outcrops of bedrock protrude from a few inches to as much as 15 feet above the soil and make up 50 to 75 percent of the complex. The soil consists mostly of sandy water-laid and windlaid material 5 to more than 60 inches deep. It is light colored and contains little organic matter. The root zone is shallow, and the water-supplying capacity and natural fertility are low. The principal concerns are wind erosion and fire. The complex is not subject to overflow. Slopes are 0 to 30 percent.

This complex is poorly suited to grazing. Large areas are idle because they are not readily accessible to livestock. In the northwestern part of the survey area, some drought-resistant woody species occur. Capability subclass VIIIs; not placed in a range site.

Sherar Series

The Sherar series consists of well drained soils formed in loess and gravelly colluvium on uplands. Slopes are 5 to 70 percent. Elevation is 1,500 to 2,500 feet. The vegetation is bunchgrasses forbs, and shrubs. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 48 to 52° F, and the frost-free period is 120 to 170 days at 32° and 170 to 200 days at 28°.

In a representative profile the surface layer is very dark grayish brown cobbly loam and clay loam about 9 inches thick. The upper 9 inches of the subsoil is dark brown clay, and the lower 11 inches is dark brown gravelly clay. The upper 6 inches of the substratum is dark brown very gravelly clay. Rippable bedrock is at a depth of about 35 inches. The soil material throughout the profile is neutral.

Permeability is slow, and the available water capacity is 2 to 6 inches. Water-supplying capacity is 2 to 5 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for range and wildlife habitat.

Representative profile of Sherar cobbly loam, 5 to 45 percent slopes, 35 feet upslope from road in the NW1/4NE1/4SW1/4 section 29, T. 3 S., R. 14 E.:

A11-0 to 3 inches; very dark grayish brown (10YR 3/2) cobbly loam; grayish brown (10YR 5/2) dry; moderate thin platy and weak very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 20 percent cobbles and 5 percent pebbles; neutral; abrupt smooth boundary.

A12-3 to 9 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine roots; many very fine tubular pores; 10 percent cobbles and 5 percent pebbles; neutral; abrupt smooth boundary.

IIB2t-9 to 18 inches dark brown (7.5YR 3/3) clay, dark brown (7.5YR 4/4) dry; weak medium prismatic structure parting to strong medium subangular blocky; extremely hard, very firm, very sticky and very plastic; few roots; many very fine tubular pores; common thin clay films; 10 percent cobbles and 5 percent pebbles neutral; clear wavy boundary.

IIB3t-18 to 29 inches; dark brown (7.5YR 4/3) gravelly clay, dark brown (7.5YR 4/4) dry; weak medium subangular blocky structure; extremely hard, firm, sticky and plastic; few roots; common very fine tubular pores; common thin clay films; 30 percent pebbles and 5 percent cobbles neutral; clear wavy

IIC1-29 to 35 inches; dark brown (7.5YR 4/3) very gravelly clay, dark brown (7.5YR 4/4) moist; massive; extremely hard, v firm, very sticky and very plastic 45 percent pebbles and percent cobbles; neutral; clear wavy boundary.

IIIC2-35 to 50 inches; dark brown (10YR 4/3) moist; very cobbly semi-consolidated extremely hard breccia.

The A horizon is very dark grayish brown or dark brown when moist. It is cobbly loam, cobbly clay loam, or clay loam and is 5 to 10 percent pebbles and 10 to 25 percent cobbles. The B horizon is dark brown or yellowish brown when dry and dark brown or brown when moist. It is clay or gravelly clay. It is 40 to 50 percent clay, 5

to 30 percent pebbles, and 10 to 20 percent cobbles. Depth to rippable bedrock is 20 to 40 inches.

40E-Sherar cobbly loam, 5 to 45 percent slopes. A representative mapping unit is in the NW1/4NE1/4SE1/4 section 29, T. 3 S., R. 14 E. This soil is in broad, irregularly shaped areas and has south-facing slopes. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Sinamox soils that make up as much as 1 percent of the unit.

Runoff is medium to rapid, and the hazard of erosion is moderate to severe. Capability subclass VIe; Shrubby South Exposure range site.

41F-Sherar very cobbly loam, 45 to 70 percent slopes. A representative mapping unit is in the SE1/4NE1/4SW1/4 section 1, T. 4 S., R. 14 E. This soil is in long, broad, irregularly shaped areas and has south-facing slopes. It has a profile similar to the one described as representative of the series, but the surface layer is very cobbly.

Included with this soil in mapping were areas of Sinamox soils that make up as much as 2 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIe; Droughty Steep South range site.

Sinamox Series

The Sinamox series consists of well drained soils formed in loess and gravelly colluvium on uplands. Slopes are 1 to 70 percent. Elevation is 1,600 to 2,600 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 48° to 52° F, and the frost-free period is 120 to 170 days at 32° and 170 to 200 days at 28°.

In a representative profile the surface layer is black and very dark grayish brown silt loam about 24 inches thick. The subsoil is dark brown silt loam about 9 inches thick. The upper 16 inches of the substratum is brown gravelly clay loam, and the lower 14 inches is dark yellowish brown silty clay. Rippable bedrock is at a depth of about 63 inches. The soil material in the profile is neutral to a depth of 49 inches and moderately alkaline below that depth.

Permeability is moderately slow, and the available water capacity is 5 to 11 inches. Water-supplying capacity is 6 to 9 inches. Effective rooting depth is 40 to 60 inches or more.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

Representative profile of Sinamox silt loam, 45 to 70 percent slopes, in SW1/4SW1/4SW1/4, section 12, T. 4 S., R. 13 E.:

A11-0 to 3 inches; black (10YR 2/1) silt loam, grayish brown (10YR 5/2) dry; weak medium platy and weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.

A12-3 to 9 inches; black (10YR 2/1) silt loam, grayish brown (10YR 5/2) dry; weak fine granular and weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear wavy boundary.

A3-9 to 24 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 4/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear wavy boundary.

B2-24 to 33 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear wavy boundary.

IIC1-33 to 49 inches; brown (10YR 4/3) gravelly clay loam pale brown (10YR 6/3) dry; massive; hard, firm, sticky and plastic; few very fine roots; common very fine tubular pores; 25 percent pebbles; neutral; clear wavy boundary.

IIIC2ca-49 to 63 inches; dark yellowish brown (10YR 4/4) silty clay, light yellowish brown (10YR 6/4) moist; massive; extremely hard, very firm, sticky and very plastic; 10 percent pebbles; moderately alkaline; weakly calcareous; abrupt wavy boundary.

IVC3-63 to 70 inches; dark brown (10YR 4/3) moist; semiconsolidated very cobbly breccia.

The A horizon is very dark grayish brown or grayish brown when dry and very dark grayish brown, very dark brown or black when moist. The B horizon is dark brown or brown when dry and very dark grayish brown or dark brown when moist. It is silt loam and is 13 to 22 percent clay. Depth to rippable bedrock is 40 to 60 inches or more.

42B-Sinamox silt loam, 1 to 7 percent slopes. A representative mapping unit is in the SWl/4SW1/4SE1/4 section 28, T. 3 S., R. 14 E. This soil is on ridgetops in long, broad, irregularly shaped areas.

Included with this soil in mapping were areas of Sherar soils that make up about 5 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIe-3; Shrubby Rolling Hills range site.

42C-Sinamox silt loam, 7 to 12 percent slopes. A representative mapping unit is in the NE1/4SW1/4SE1/4, section 6, T. 4 S., R. 14 E. This soil is on ridgetops in long, broad, irregularly shaped areas.

Included with this soil in mapping were areas of Sherar soils that make up about 6 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-5; Shrubby Rolling Hills range site.

42D-Sinamox silt loam, 12 to 20 percent slopes, A representative mapping unit is in the NE1/4NE1/4NE1/4 section 32, T. 3 S., R. 14 E. This soil is in long, narrow areas and has north-facing slopes.

Included with this soil in mapping were areas of Sherar soils that make up about 6 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-7 ; Shrubby Rolling Hills range site.

42E-Sinamox silt loam, 20 to 45 percent slopes. A representative mapping unit is in the NE1/4SW1/4SW1/4 section 36, T. 8 S., R. 13 E. This soil is in long, narrow areas and has north-facing slopes.

Included with this soil in mapping were areas of

Sherar soils that make up as much as 10 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIe; Droughty North Exposure range site.

42F-Sinamox silt loam, 45 to 70 percent slopes. A representative mapping unit is in the SW1/4SW1/4SW1/4 section 12, T. 4: ., R. 13 E. This soil is in long, narrow areas and has north-facing slopes. It has a profile described as representative of the series.

Included with this soil in mapping were areas of Sherar soils that make up as much as 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIe; Steep North range site.

Skyline Series

The Skyline series consists of well drained soils formed in loess, volcanic ash, and colluvium over bedrock on uplands. Slopes are 5 to 70 percent. Elevation is 500 to 3,500 feet. The vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 14 to 20 inches, the average annual air temperature is 47° to 49° F, and the frost-free period is 110 to 140 days at 32° and 140 to 160 days at 28°.

In a representative profile the surface layer is very dark grayish brown very cobbly loam and cobbly loam about 9 inches thick. The subsoil is dark brown gravelly loam about 5 inches thick. Sandstone bedrock is at a depth of about 16 inches. The soil material in the profile is neutral.

Permeability is moderate, and the available water capacity is 1 to 3 inches. Water-supplying capacity is 6 to 9 inches. Effective rooting depth is 12 to 20 inches.

These soils are used for range and wildlife habitat.

Representative profile of a Skyline very cobbly loam in an area of Skyline-Hesslan complex, 40 to 65 percent slopes, 1,000 feet north of the county road in the NE1/4NE1/4NW1/4 section 26, T. 1 S., R. 12 E.:

A1-0 to 2 inches; very dark grayish brown (10YR 3/2) very cobbly loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 20 percent fine and medium pebbles; 20 percent cobbles, and 10 percent stones; neutral; abrupt smooth boundary.

A3-2 to 9 inches; very dark grayish brown (10YR 3/2) cobbly loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 10 percent fine pebbles and 16 percent cobbles; neutral; clear smooth boundary.

B2-9 to 14 inches; dark brown (10YR 3/3) gravelly loam, brown (10YR 4/3) dry weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 15 percent pebbles and 10 percent cobbles; neutral; abrupt wavy boundary.

IIC-14 to 16 inches; semiconsolidated sandstone bedrock,

The A horizon is grayish brown, brown, or dark grayish brown when dry and very dark grayish brown or dark brown when moist. It is cobbly loam or very cobbly loam and is 20 to 40 percent rock fragments 2 millimeters to 10 inches in size. The content of surface stones is 5 to 20 percent. The B horizon is grayish brown or brown when dry and very dark grayish brown or dark brown when moist. It is cobbly loam to cobbly heavy loam and is 10 to 30 percent rock fragments 2 millimeters to 10 inches in size. It has weak to moderate, medium, subangular blocky structure. The soil is 12 to 20 inches deep to semiconsolidated sandstone bedrock.

43F-Skyline-Hesslan complex, 40 to 65 percent slopes. A representative mapping unit is in the NE1/4NE1/4NW1/4 section 26, T. 1 S., R. 12 E. This complex is about 50 to 70 percent a Skyline very cobbly loam and 10 to 30 percent a Hesslan stony loam. The Skyline soil has south-facing slopes, and the Hesslan soil has north-facing side slopes. The soils have the profiles described as representative of their respective series.

Included with this complex in mapping were areas of Frailey loam and Wamic loam. These soils make up about 20 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. This complex is used for range and wildlife habitat. Capability subclass VIIs ; Oak Steep South range site.

Tygh Series

The Tygh series consists of somewhat poorly drained soils on bottom lands. They formed in alluvium derived from volcanic ash, loess, and weathered sedimentary rocks. Slopes are 0 to 3 percent. Elevation is 200 to 1,800 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 14 to 20 inches, the average annual air temperature is 48° to 52° F, and the frost-free period is 130 to 150 days at 32° and 150 to 180 days at 28 .

In a representative profile the surface layer is very dark brown fine sandy loam about 10 inches thick. The upper 20 inches of the underlying material is dark grayish brown fine sandy loam, the next 11 inches is dark gray sandy loam, the next 5 inches is gray and dark gray loamy sand, and below this is gray to dark gray very gravelly sand to a depth of 60 inches or more. The soil material throughout the profile is neutral.

Permeability is moderately rapid, and the available water capacity is 4 to 8 inches. These soils are subject to seasonal flooding. Effective rooting depth is 40 to 60 inches.

These soils are used for dryfarmed and irrigated small grain, hay, pasture, range, and wildlife habitat.

Representative profile of Tygh fine sandy loam, 200 feet north of Fifteen Mile Creek in the NE1/4NW1/4SW1/4, section 33, T. 1 S., R. 13 E.:

Ap-0 to 10 inches; very dark brown (10YR 2/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; 2 percent gravel; neutral; abrupt smooth boundary.

C1-10 to 17 inches; dark grayish brown (10YR 4/2) fine sandy loam, light brownish y (10YR 4/2) dry; common prominent fine reddish brown 5YR 4/4) mottles; massive; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; many very fine tubular pores; 2 percent gravel; neutral; clear wavy boundary.

C2-17 to 30 inches; dark grayish brown (10YR 4/2) fine sandy loam, gray (10YR 6/1) dry; many prominent reddish brown (5YR 4/4) mottles; massive; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; many very fine tubular pores; 2 percent gravel; neutral; clear wavy boundary.

C3-30 to 41 inches; dark gray (10YR 4/1) sandy loam, gray (10YR 6/1) dry; common medium prominent reddish brown (5YR 4/4) mottles; massive; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; many very fine tubular pores; 2 percent gravel; few black (10YR 2/1) manganese stains; neutral; clear wavy boundary.

C4-41 to 46 inches; gray and dark gray (10YR 5/1-4/1) loamy sand, light gray (10YR 7/1) dry; common large prominent reddish brown (5YR 4/4) mottles; single grained; loose, nonsticky and nonplastic; few very fine roots; common very fine tubular pores; 5 percent gravel; neutral; clear wavy boundary.

IIC5-46 to 60 inches; gray to dark gray (10YR 5/1-4/1) very gravelly sand, light gray (10YR 7/I) dry; common large prominent reddish brown (5YR 4/4) mottles; single grained; loose, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; 75 percent pebbles and 5 percent cobbles; neutral.

The A horizon is fine sandy loam or very fine sandy loam. It has weak fine granular structure or is single grained. The C horizon is fine sandy loam, silt loam, or loam and has thin lenses that range from silt to medium gravel. Common to many, fine to medium, dark brown or reddish brown when moist mottles are below a depth of about 10 inches. They increase in size and number with depth.

44-Tygh fine sandy loam. A representative mapping unit is in the NE1/4NW1/4SW1/4 section 33, T. I S., R. 13 E. This soil is adjacent to streams in long strips that are about 100 to 150 feet wide. Slopes are 0 to 3 percent.

Included with this soil in mapping were areas of Endersby, Hermiston, and Pedigo soils and cobbly soils. These soils make up about 10 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. The hazard of streambank erosion is severe (fig. 6). Capability unit IIIw-1; Semi-Moist Bottom range site.

Van Horn Series

The Van Horn series consists of well drained soils formed in stratified old alluvial deposits on uplands. Slopes are 0 to 35 percent. Elevation is 100 to 850 feet. In uncultivated areas, the vegetation is Douglas-fir, ponderosa pine, forbs, and shrubs. The average annual precipitation is 20 to 25 inches, the average annual air temperature is 49 to 52 F, and the frost-free period is 150 to 180 days at 32° and 180 to 210 days at 28 .

In a representative profile the surface layer is very dark grayish brown and dark brown loam about 11 inches thick. The subsoil is dark brown loam and clay loam about 38 inches thick. The substratum is dark brown loam 11 inches or more thick. The soil material in the profile is slightly acid or neutral.

Permeability is moderate, and the available water capacity is 8 to 9 inches. Water-supplying capacity is 12 to 15 inches. Effective rooting depth is more than 60 inches.

These soils are used mostly for fruit orchards, hay, pasture, and wildlife habitat and for some range.

Representative profile of Van Horn loam, 8 to 12 percent slopes, in the NE1/4SW1/4NW1/4 section 18, T. 2N., R. 11 E.:

A1p-0 to 5 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 5/3) dry; weak medium granular structure; slightly hard, very friable, slightly sticky

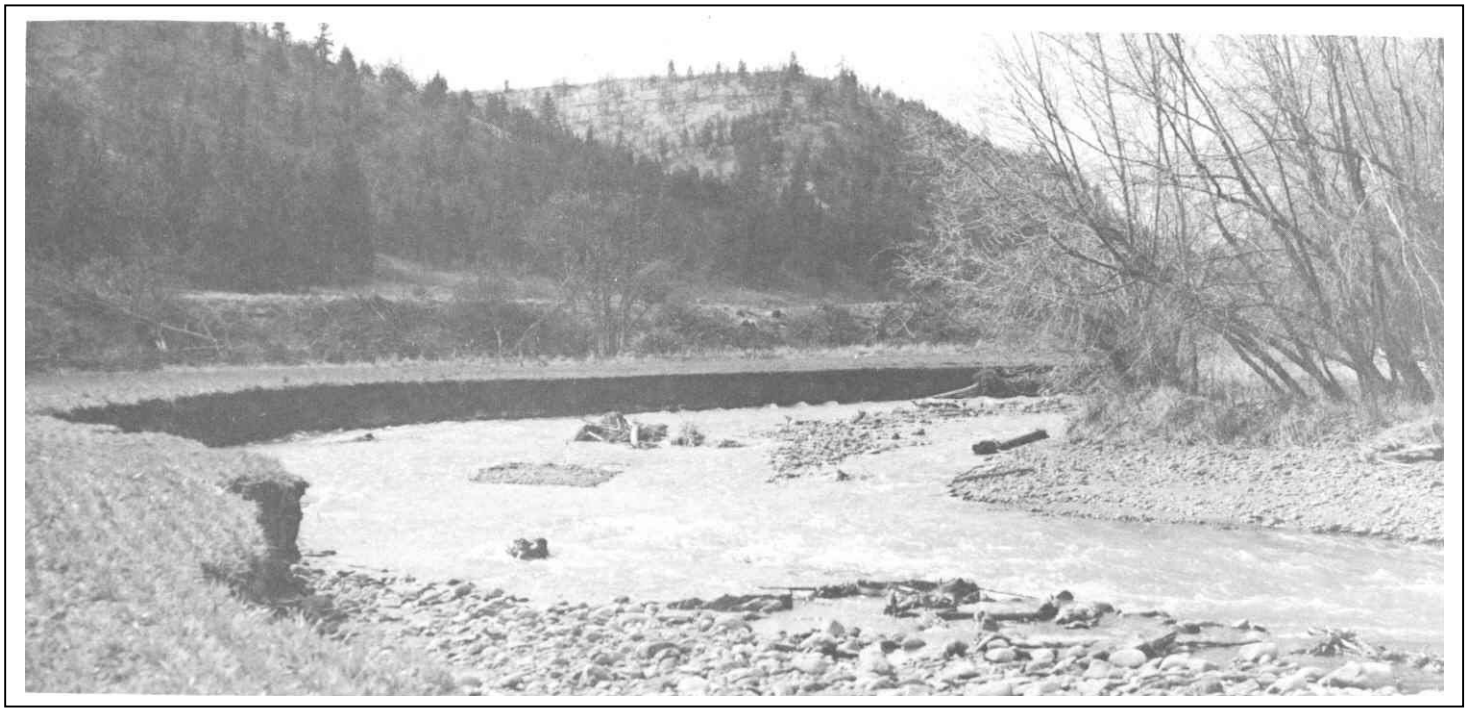

Figure 6.-Streambank erosion on Tygh fine sandy loam.

and slightly plastic; many very fine roots; many very fine irregular pores; slightly acid; abrupt smooth boundary.

A12-5 to 11 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky an slightly plastic; many very fine roots; common very fine tubular pores; slightly acid; clear smooth boundary.

B1-11 to 21 inches; dark brown (10YR 3/3) loam, grayish brown (10YR 5/3) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; slightly acid; clear smooth boundary.

B21t-21 to 33 inches; dark brown (10YR 3/3) heavy loam, brown (10YR 6/3) dry; moderate medium subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; few thin clay films on ped faces and common moderately thick clay films in pores; many gray (10YR 7/2) sand coatings on peds; slightly acid; gradual smooth bounds .

B22t-33 to 49 inches; dark brown (10YR 3/3) clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; very hard, firm, sticky and slightly plastic; few very fine roots; many very fine tubular pores; few thin clay films on ped faces and common thin clay films in pores; many gray (10YR 7/2) sand coatings on peds; neutral; gradual smooth boundary.

C-49 to 60 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral.

The A horizon is grayish brown or brown when dry and very dark grayish brown or dark brown when moist. It is very fine sandy loam, fine sandy loam, or loam. The B2 horizon is light brownish gray, pale brown, brown, or yellowish brown when dry and dark brown, dark yellowish brown, or dark grayish brown when moist. It is clay loam, sandy clay loam, or heavy loam and is 22 to 35 percent clay.

45B-Van Horn loam, 0 to 8 percent slopes. A representative mapping unit is in the NW1/4SE1/4NW1/4 section 7, T. 2 N., R. 12 E. This soil is in broad, irregularly shaped areas.

Included with this soil in mapping were areas of Chenoweth, Cherryhill, and Wind River soils. These soils make up about 10 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit Ile-1; Pine-Oak-Fescue range site.

45C-Van Horn loam, 8 to 12 percent slopes. A representative mapping unit is in the NE1/4SW1/4NW1/4 section 18, T. 2 N., 11 E. This soil is in broad, irregularly shaped areas. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Chenoweth, Cherryhill, and Wind River soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-2; Pine-Oak-Fescue range site.

45D-Van Horn loam, 12 to 20 percent slopes. A representative mapping unit is in the NW1/4NW1/4NW1/4 section 7, T. 2 N., R. 12 E. This soil is in long, narrow, irregularly shaped areas.

Included with this soil in mapping were areas of Chenoweth, Cherryhill, and Wind River soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-2; Pine-Oak-Fescue range site.

45E-Van Horn loam, 20 to 35 percent slopes. A representative mapping unit is in the SE1/4SE1/4SW1/4, section 6, T. 2 N., R. 12 E. This soil is in narrow, irregularly shaped areas.

Included with this soil in mapping were areas of Chenoweth, Cherryhill, and Wind River soils. These soils make up about 10 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability unit IVe-1; Pine-Oak-Fescue range site.

Walla Walla Series

The Walla Walla series consists of well drained soils formed in loess on uplands. Slopes are 3 to 60 percent. Elevation is 300 to 2,000 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 12 to 14 inches, the average annual air temperature is 49° to 62° F, and the frost-free period is 160 to 170 days at 32° and 170 to 210 days at 28°.

In a representative profile the surface layer is very dark brown silt loam about 13 inches thick. The subsoil is dark brown and brown silt loam about 18 inches thick. The substratum is dark yellowish brown silt loam to a depth of 82 inches or more. The surface layer is slightly acid and neutral, the subsoil is neutral, and the substratum is neutral and mildly alkaline.

Permeability is moderate, and the available water capacity is 7 to 12 inches. Water-supplying capacity is 8 to 12 inches. Effective rooting depth is 40 to 60 inches or more.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

Representative profile of Walla Walla silt loam, 12 to 20 percent north slopes, about 600 feet north of the line between sections 12 and 13 in the SE1/4SW1/4SW1/4, section 12, T. 1 N., R. 14 E.:

Ap-0 to 7 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak thin platy structure parting to weak fine granular; soft to slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; slightly acid; abrupt smooth boundary.

A12-7 to 13 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak medium platy structure parting to weak fine granular; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; abrupt smooth boundary.

B1-13 to 20 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to very weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; neutral ; clear smooth boundary.

B2-20 to 31 inches; brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to very weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; gradual smooth boundary.

C11-31 to 44 inches; dark yellowish brown (10YR 3/4) silt loam, pale brown (10YR 6/3) dry; massive;

slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; neutral; gradual smooth boundary.

C12-44 to 82 inches; dark yellowish brown (10YR 3/4) silt loam, pale brown (10YR 6/3) dry' massive; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; mildly alkaline.

The A horizon is dark grayish brown, grayish brown, or brown when dry and very dark brown, very dark grayish brown, or dark brown when moist. It is silt loam or coarse silt loam. The B horizon is silt loam or coarse silt loam. The C horizon is light brownish gray or pale brown when dry and dark yellowish brown or brown when moist. It is silt loam or coarse silt loam. Lime in mycelium form is below a depth of 55 inches in some places. Depth to bedrock is 40 to more than 60 inches.

46B-Walla Walla silt loam, 3 to 7 percent slopes. A representative mapping unit is in the SW1/4SW1/4SW1/4 section 2, T. 1 N., R. 15 E. This soil is on ridgetops in broad, smooth, convex areas.

Included with this soil in mapping were areas of Anderly and Nansene soils. These soils make up about 5 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-3; Rolling Hills range site.

46C-Walla Walla silt loam, 7 to 12 percent slopes. A representative mapping unit is in the SW1/4SW1/4SW1/4 section 3, T. 1 N., R. 15 S. This soil is on ridgetops in broad, smooth, convex areas.

Included with this soil in mapping were areas of Anderly and Nansene soils. These soils make up about 5 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-1; Rolling Hills range site.

46D-Walla Walla silt loam, 12 to 20 percent north slopes. A representative mapping unit is in the SE1/4SWl/4SW1/4 section 12, T. 1 N., R. 14 E. This soil is in long, broad, convex areas. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Anderly and Nansene soils. These soils make up about 5 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-4; Droughty North Exposure range site.

47D-Walla Walla silt loam, 12 to 20 percent south slopes. A representative mapping unit is in the SW1/4SW1/4SWI/4 section 6, T. 1 N., R. 15 E. This soil is in long, broad, convex areas.

Included with this soil in mapping were areas of Anderly and Nansene soils that makeup about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-4; Rolling Hills range site.

47E-Walla Walla silt loam, 20 to 35 percent north slopes. A representative mapping unit is in the NE1/4SW1/4SW1/4 section 9, T. 1 N., R. 14 E. This soil is in long, broad, irregularly shaped areas.

Included with this soil in mapping were areas of Anderly and Nansene soils that make up about 10 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability unit IVe-3 ; North Exposure range site.

48E-Walla Walla silt loam, 20 to 35 percent south slopes. A representative mapping unit is in the NW1/4NW1/4NW1/4 section 10, T. 1 N., R. 14 E. This soil is in long, broad, irregularly shaped areas.

Included with this soil in mapping were areas of Anderly and Nansene soils that make up about 10 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability unit IVe-2; Droughty South Exposure range site.

48F-Walla Walla silt loam, 35 to 50 percent south slopes. A representative mapping unit is in the W1/4SE1/4NE1/4 section 7, T. 1 **N.,** R. 14 E. This soil is in long, narrow, irregularly shaped areas.

Included with this soil in mapping were areas of Anderly and Nansene soils that make up about 10 percent of this mapping unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIe; Droughty South Exposure range site.

Wamic Series

The Wamic series consists of well drained soils formed in volcanic ash, and loess overlying alluvium or colluvium weathered from basalt or andesite on uplands. Slopes are 1 to 70 percent. Elevation is 1,000 to 3,600 feet. In uncultivated areas, the vegetation is ponderosa pine, Douglas-fir, oak forbs, and shrubs. The average annual precipitation is 14 to 20 inches, the average annual air temperature is 46° to 50° F, and the frost-free period is 100 to 150 days at 32° and 150 to 200 days at 28°.

In a representative profile the surface layer is very dark grayish brown loam about 7 inches thick. The subsoil is dark brown loam about 21 inches thick. The substratum is dark brown heavy loam 16 or more inches thick. The soil material throughout the profile is neutral.

Permeability is moderately slow, and the available water capacity is 6.5 to 11 inches. Water-supplying capacity is 8 to 12.5 inches. Effective rooting depth is 40 to 60 inches or more.

These soils are used for dryfarmed small grain, hay, pasture, range, timber, and wildlife habitat.

Representative profile of Wamic loam, 5 to 12 percent south slopes, 100 feet south of road in the NE1/4NW1/4NW1/4 section 26, T. 2 S., R. 12 E.:

Ap-0 to 7 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; weak tune granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.

B1-7 to 18 inches; dark brown (10YR 3/3) loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear wavy boundary.

B2-18 to 28 inches; dark brown (10YR 4/3) loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many

very fine and common fine tubular pores; about 2 percent very fine pebbles; light gray (10YR 7/2) when dry coatings of very fine sand on peds; neutral; abrupt wavy boundary.

IIC-28 to 44 inches; dark brown (10YR 4/3) heavy loam, pale brown (10YR 4/3) dry; massive; very hard, firm, sticky and plastic; few fine roots; many very fine and common fine tubular pores; about 2 percent very fine pebbles; brown (7.5YR 4/4) when dry thick clay films in nearly all pores and on faces of fractures; neutral.

IIIR-44 inches; basalt bedrock.

The A horizon is light brownish gray or pale brown when dry and very dark grayish brown or dark brown when moist. It is loam, very fine sandy loam, or silt loam. It has weak granular or subangular blocky structure. The B horizon is light brownish gray, pale brown, or light yellowish brown when dry and dark brown, brown, or dark yellowish brown when moist. It is loam or silt loam, is 18 to 22 percent clay, and is more than 15 percent particles coarser textured than very fine sand. The substratum is pale brown or light yellowish brown when dry and brown or dark yellowish brown when moist. It is heavy loam, foam, or sandy clay loam and is 20 to 80 percent clay.

The amount of ash in the soil ranges from 20 to 60 percent. Depth to bedrock is 40 to 60 inches or more.

49B-Wamic loam, 1 to 5 **percent slopes.** A representative mapping unit is in the SW1/4SE1/4SW1/4 section 26, T. 1 N., R. 12 E. This soil is on ridgetops in broad, smooth, convex areas.

Included with this soil in mapping were areas of Bald, Bodell, Hesslan, Skyline, and Frailey soils. These soils make up about 6 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIIe-1; Pine-Oak-Fescue range site; woodland group 60.

49C-Wamic loam, 5 to 12 percent north slopes. A representative mapping unit is in the SE1/4NW1/4NW1/4 section 36, T. 2 S., R. 12 E. This soil is on ridgetops in broad, smooth areas.

Included with this soil in mapping were areas of Bald, Bodell, Hesslan, Skyline, and Frailey soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-4; Pine-Oak-Fescue range site; woodland group 60.

50C-Wamic loam,. 5 to 12 percent south slopes. A representative mapping unit is in the NE1/4NW1/4NW1/4 section 26, T. 2 S., R. 12 E. This soil is in long, irregularly shaped areas and has south-facing slopes. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Bald, Bodell, Hesslan, Skyline, and Frailey soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-5; Oak South Exposure range site.

50D-Wamic loam, 12 to 20 percent slopes. A rep representative mapping unit is in the SE1/4SE1/4SE1/4 section 14, T. 2 S., R. 14 E. This soil is in irregularly shaped areas.

Included with this soil in mapping were areas of Bald, Bodell, Hesslan, Skyline, and Frailey soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-4; Pine-Oak-Fescue range site; woodland group 60.

50E-Wamic loam, 20 to 40 percent slopes. A representative mapping unit is in the NE1/4NE1/4NE1/4 section 31, T. 2 S., R. 13 E. This soil is in long, broad areas and narrow, irregularly shaped areas.

Included with this soil in mapping were areas of Bald, Hesslan, Skyline, and Frailey soils. These soils make up about 10 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIe; Pine-Douglas Fir-Sedge range site; woodland group 6r.

50F-Wamic loam, 40 to 70 percent slopes. A representative mapping unit is in the NE1/4SW1/4SW1/4 section 10, T. 2 N., R. 12 E. This soil is in long, narrow, irregularly shaped areas. It has a profile similar to the one described as representative of the series, but the surface layer is darker colored.

Included with this soil in mapping were areas of Bald, Hesslan, Frailey, and Skyline soils. These soils make up as much as 20 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIe; Pine-Douglas Fir-Sedge range site; woodland group 6r.

51D-Wamic-Skyline complex, 2 to 20 percent slopes. A representative mapping unit is in the NW1/4NW1/NE1/4 section 86, T. 2 S., R. 12 E. This 4complex is about 46 to 70 percent a Wamic loam and about 16 to 40 percent a Skyline very cobbly loam. The Wamic soil is on ridgetops or side slopes in circular or elongated mounds. The Skyline soil is in areas where the ridgetops break off into canyons.

Included with this complex in mapping were areas of very shallow, very stony, and deep stony soils. These soils make up about 20 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. This complex is used for range and wildlife habitat. Capability subclass VIe; Wamic soil in Oak South Exposure range site; Skyline soil in Oak Steep South range site.

Wapinitia Series

The Wapinitia series consists of well drained soils, formed in loess and volcanic ash on uplands. Slopes are 0 to 36 percent. Elevation is 1,800 to 3,400 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 13 to 16 inches, the average annual air temperature is 48° to 60° F, and the frost-free period is 120 to 170 days at 32° and 170 to 200 days at 28°.

In a representative profile the surface layer is very dark brown silt loam about 6 inches thick. The upper 13 inches of the subsoil is very dark brown silt loam, and the lower 10 inches is dark brown silty clay loam. The upper 7 inches of the substratum is dark yellowish brown fine sandy loam, and the lower 14 inches is dark brown clay loam. Basalt bedrock is at a depth of about 60 inches. The surface layer and upper part of the subsoil are slightly acid, and the lower part of the subsoil and the substratum is neutral.

Permeability is moderately slow, and the available water capacity is 7 to 12 inches. Water-supplying capacity is 10 to 14 inches. Effective rooting depth is 40 to 60 inches.

These soils are used for small grain, dryfarmed hay, pasture, range, irrigated crops, and wildlife habitat.

Representative profile of Wapinitia silt loam in an area of Watama-Wapinitia silt loams, 0 to 5 percent slopes, 50 feet east of graveled county road and 450 feet south of main irrigation canal in the NW1/4NE1/4SE1/4 section 17, T. 5 S., R. 12 E.:

Ap-0 to 6 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; slightly acid; abrupt smooth boundary.

B1-6 to 19 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine and fine tubular pores; few thin clay films on peds; common noncalcareous nodules 1/4 to 3/4 inch in diameter; slightly acid; clear smooth boundary.

B2t-19 to 29 inches; dark brown (10YR 3/3) silty clay loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; many very fine roots; many to common very fine and fine tubular pores; many thin clay films on peds; common noncalcareous nodules 1/4 to 3/4 inch in diameter; neutral; clear smooth boundary.

IICI-29 to 36 inches; dark yellowish brown (10YR 3/4) fine sandy loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common fine tubular pores; common clay bridges; neutral; clear smooth boundary.

IIC2-36 to 50 inches; dark brown (10YR 4/3) clay loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; neutral; abrupt smooth boundary.

IIIR-50 inches; basalt bedrock.

The A horizon is dark grayish brown or grayish brown when dry and very dark brown or very dark grayish brown when moist. It is silt loam or loam. The B horizon is grayish brown or brown when dry. It is clay loam or silty clay loam and is 27 to 35 percent clay. It contains 2 to 5 percent noncalcareous nodules 1/4 to 3/4 inch in diameter and more than 16 percent particles coarser textured than very fine sand. The horizon is fine sandy loam, loam, or clay loam. Depth to basalt bedrock is 40 to 60 inches.

The Wapinitia series is mapped only in complexes with Watama sods. Refer to the Watama series for a description of these mapping units.

Wapinitia Variant

The Wapinitia variant consists of well drained soils formed in loess and volcanic ash on uplands. Slopes are 1 to 7 percent. Elevation is 1,800 to 3,400 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 13 to 16 inches, the average annual air temperature is 48° to 50° F, and the frost-free period is 120 to 170 days at 32° and 170 to 200 days at 28°.

In a representative profile the surface layer is very dark brown silt loam about 12 inches thick. The upper 10 inches of the subsoil is very dark grayish brown silty clay loam, and the lower 31 inches is dark brown and brown clay. Basalt is at a depth of 53 inches. The surface layer and subsoil are neutral.

Permeability is slow, and the available water capacity is 7 to 11.5 inches. Water-supplying capacity is 10 to 13 inches. Effective rooting depth is 40 to 60 inches.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

Representative profile of Wapinitia variant silt loam, 1 to 7 percent slopes, 100 feet north of road in the SW1/4SE1/4SW1/4 section 28, T. 5 S., R. 12 E.:

Ap1-0 to 5 inches; very dark brown (10YR 2/2) silt loam, dark brown (10YR 4dry; weak very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.

Ap2-5 to 12 inches; very dark brown (10YR 2/2) loam, dark brown (10YR 4/3) dry; moderate fine granular and weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; neutral; abrupt smooth boundary.

B1-12 to 22 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; hard, firm, sticky and very plastic; many very fine roots; many very fine tubular pores; neutral; abrupt smooth boundary.

IIB21t-22 to 32 inches; dark brown (10YR 3/3) clay, brown (10YR 6/3) dry; weak medium prismatic and strong medium blocky structure; extremely hard, very firm, very sticky and very plastic; few very fine roots; few very fine tubular pores; common thin clay films on peds; 5 percent pebbles 2 millimeters to 3 inches in size; neutral; clear wavy boundary.

IIB22t-32 to 63 inches; brown (10YR 4/3) clay, brown (10YR 5/3) dry; weak medium prismatic and strong medium blocky structure; extremely hard, very firm, sticky and very plastic; few very fine roots; few very fine tubular pores; common moderately thick clay films on peds; 5 percent pebbles 2 millimeters to 3 inches in size; neutral; abrupt smooth boundary.

IIIR-53 to 60 inches; basalt.

The A horizon is silt loam or loam. Depth to bedrock is 40 to 60 inches or more.

52B-Wapinitia variant silt loam, 1 to 7 percent slopes. A representative mapping unit is in SW1/4SE1/4SW1/4 section 28, T. 5 S., R. 12 E. This soil is in narrow, irregularly shaped areas. Slopes average about 4 percent.

Included with this soil in mapping were areas of Wapinitia, Watama, and Bakeoven soils. These soils make up about 10 percent of the unit.

Runoff is slow, and the hazard of erosion is moderate. Capability unit IIIe-5; Shrubby Rolling Hills range site.

Warden Series

The Warden series consists of well drained soils formed in a loess mantle over calcareous, silty lacustrine sediment on terraces. Slopes are 5 to 40 percent. Elevation is 600 to 1,000 feet. The vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is about 9 inches, the average annual air temperature is 51° to 53° F, and the frost-free period is 130 to 180 days at 32° and 180 to 200 days at 28°.

In a representative profile the surface layer is very dark grayish brown and dark brown silt loam about 8 inches thick. The subsoil is dark brown silt loam about 13 inches thick. The substratum is dark grayish brown silt loam about 39 inches thick. The substratum is dark grayish brown silt loam about 39 inches thick. The soil material in the profile is neutral to strongly alkaline. Lime accumulation is at a depth of 20 to 30 inches.

Permeability is moderate, and the available water capacity is 10 to 12 inches. Water-supplying capacity is 6 to 9 inches. Effective rooting depth is 40 to 60 inches or more.

These soils are used for hay, pasture, range, and wildlife habitat.

Representative profile of Warden silt loam, 5 to 40 percent slopes, in abandoned field 30 feet northeast of Sinamox Road in the SE1/4SW1/4NE1/4 section 27, T. 2 S., R. 15 E.

A1-0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate medium platy structure parting to weak fine granular; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; abrupt smooth boundary.

A12-3 to 8 inches; dark brown (10YR 3/3) silt loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; common fine tubular pores; neutral; abrupt wavy boundary.

B2-8 to 21 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; mildly alkaline; abrupt wavy boundary.

IIC1ca-21 to 34 inches; dark grayish brown (2.5Y 4/3) silt loam, pale brown (10YR 613) dry; massive; hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; many fine to medium (1/4 to 1 inch) calcareous concretions; moderately alkaline; strongly calcareous; clear wavy boundary.

IIC2ca-34 to 45 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (10YR 6/2) dry; massive; slightly hard, friable and firm, slightly sticky an slightly plastic; common very fine roots; many fine tubular pores; strongly alkaline; strongly calcareous; clear wavy boundary.

IIC3ca-45 to 60 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; massive; hard, friable, slightly sticky and slightly plastic; few roots; many very fine irregular pores; strongly alkaline; strongly calcareous.

The A horizon is grayish brown or light brownish gray when dry. The B horizon is brown or pale brown when dry and dark brown or dark yellowish brown when moist. The C horizon is light brownish gray, brown, or pale brown when dry and grayish brown or dark grayish brown when moist. It is as much as 5 percent calcareous concretions v4 to I inch in diameter. It is moderately calcareous to strongly calcareous.

53E-Warden silt loam, 5 to 40 percent slopes. A representative mapping unit is in the SE1/4SW1/4NE1/4 section 27, T. 2 S., R. 15 E. This soil is in narrow and broad, irregularly shaped, dissected terraces.

Included with this soil in mapping were areas of Lickskillet and Wrentham soils. These soils make up as much as 10 percent of the unit.

Runoff is medium or slow, and the hazard of erosion is slight to severe. Capability subclass VIe; Silty Terrace range site.

Watama Series

The Watama series consists of well drained soils formed in loess and volcanic ash on uplands. Slopes are 0 to 35 percent. Elevation is 1,800 to 3,400 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 13 to 16 inches, the average annual air temperature is 48° to 50° F, and the frost-free period is 120 to 170 days at 32° and 170 to 200 days at 28°.

In a representative profile the surface layer is very dark brown and very dark grayish brown silt loam about 10 inches thick. The upper 14 inches of the subsoil is dark brown loam, and the lower 10 inches is brown clay loam. Basalt bedrock is at a depth of about 34 inches. The soil material in the profile is neutral throughout.

Permeability is moderately slow; and the available water capacity is 3.5 to 8 inches. water-supplying capacity is 6 to 10 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for dryfarmed small grain, hay, pasture, range, irrigated crops, and wildlife habitat.

Representative profile of a Watama silt loam in an area of Watama-Wapinitia silt loams, 0 to 5 percent slopes, 75 feet south of gravel roast in the NE1/4NWl/4NE1/4 section 16, T. 5 S., R. 12 E.:

A11-0 to 4 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 6/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.

A12-4 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear smooth boundary.

B1-10 to 17 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak to moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; clear smooth boundary.

B21-17 to 24 inches; dark brown (10YR 3/3) heavy loam, brown (10YR 6/3) dry; weak coarse prismatic and moderate medium subangular blocky structure; very hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; common very dark grayish brown (10YR 3/2) coatings on peds; 2 percent cobbles; neutral; clear smooth boundary.

B22-24 to 34 inches; brown (10YR 4/3) light clay loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; very hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; common dark brown (10YR 3/3) coatings on peds; 2 percent cobbles; neutral; clear smooth boundary.

IIR-34 inches; basalt bedrock.

Depth to basalt bedrock is 20 to 40 inches.

54B-Watama-Wapinitia silt loams, 0 to 5 percent slopes. A representative mapping unit is in the NE1/4NW1/4NEl/4 section 16, T. 5 S., R. 12 E. This complex is about 55 to 65 percent a Watama silt loam and 25 to 30 percent a Wapinitia silt loam. These soils are in narrow, irregularly shaped areas. Slopes average about 3 percent. Both soils have the profile described as representative of their respective series.

Included with this complex in mapping are areas of

Bakeoven, Maupin, and Wamic soils. These soils make up as much as 15 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-3 nonirrigated, and IIe-2 irrigated; Shrubby Rolling Hills range site.

54C-Watama-Wapinitia silt loams, 5 to 12 percent slopes. A representative mapping unit is in the NW1/4SW1/4SE1/4 section 3, T. 5 S., R. 12 E. This complex is about 65 to 65 percent a Watama silt loam and 25 to 30 percent a Wapinitia silt loam. These soils are on ridgetops in long, broad or narrow areas.

Included with this complex in mapping were areas of Bakeoven, Maupin, and Wamic soils. These soils make up as much as 15 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-4; Shrubby Rolling Hills range site.

54D-Watama-Wapinitia silt loams, 12 to 20 percent slopes. A representative ma in unit is in the SE1/4SE1/4SW1/4 section 3, T. 5 S., 12 E. This complex is about 55 to 65 percent a Watama silt loam and 25 to 35 percent a Wapinitia silt loam. These soils are in long, narrow, irregularly shaped areas.

Included with this complex in mapping were areas of Bakeoven, Maupin, and Wamic soils. These soils make up as much as 15 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-4; Shrubby Rolling Hills Range site.

54E-Watama-Wapinitia silt loams, 20 to 35 percent slopes. A representative mapping unit is in the NW1/4NE1/4NW1/4 section 3, T. 5 S., R. 12 E. This complex is about 55 to 65 percent a Watama silt loam and 25 to 35 percent a Wapinitia silt loam. These soils are in long, narrow, irregularly shaped areas.

Included with this complex in mapping were areas of Bakeoven, Maupin, and Wamic soils. These soils make up as much as 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability unit IVe-2; North Exposure range site.

Wato Series

The Wato series consists of well drained soils formed in loess on uplands. Slopes are 3 to 35 percent. Elevation is 300 to 1,500 feet. In uncultivated areas, the vegetation is bunchgrasses, forbs, and shrubs. The average annual precipitation is 12 to 14 inches, the average annual air temperature is 51° to 54° F, and the frost-free period is 150 to 170 days at 32° and 170 to 210 days at 28°.

In a representative profile the surface layer is very dark grayish brown very fine sandy loam about 15 inches thick. The subsoil is dark brown loam about 27 inches thick. The substratum is dark brown fine sandy loam about 24 inches thick. The soil material throughout the profile is neutral.

Permeability is moderately rapid, and the available water capacity is 6 to 10 inches. Water-supplying capacity is 7 to 10 inches. Effective rooting depth is 40 to 60 inches or more.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

Representative profile of Wato very fine sandy loam, 3 to 7 percent slopes, 150 feet west of road in the NW1/4NE1/4NW1/4 section 32, T. 2 N., R. 14 E.:

A11-0 to 3 inches; very dark grayish brown (10YR 3/2) very fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; neutral; clear smooth boundary.

A12-3 to 15 inches; very dark grayish brown (10YR 3/2) very fine sandy loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 2 percent fragments 1 to 2 millimeters in size; neutral; clear smooth boundary.

B1-15 to 21 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular an tubular pores; 2 percent fragments 1 to 2 millimeters in size; neutral; clear wavy boundary.

B2-21 to 42 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak medium prismatic and weak medium subangular bloc structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 3 percent fragments I to 2 millimeters in size; neutral; clear smooth boundary.

C1-42 to 52 inches; dark brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many to common very fine roots; many very fine tubular pores; 6 percent weathered fragments 1 to 2 millimeters in size; neutral; clear wavy boundary.

C2-52 to 66 inches; dark brown (10YR 4/3) fine sandy loam, ale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; 10 percent weathered fragments I to 2 millimeters in size; neutral; abrupt wavy boundary.

The B horizon is dark brown to brown when dry. It is very fine sandy loam to loam.

55B-Wato very fine sandy loam, 3 to 7 percent slopes. A representative mapping unit is in the NW1/4NE1/4NW1/4 section 32, T. 2 N., R. 14 E. This soil is on ridgetops in broad, irregularly shaped areas. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Lickskillet, Walla Walla, Anderly, and Nansene soils. These soils make up about 5 percent of the unit.

Runoff is slow. The hazard of water erosion is slight or moderate, and the hazard of soil blowing is moderate. Some areas are moderately eroded and have lower crop yields than noneroded areas. Capability unit IIIe-6; Rolling Hills range site.

55C-Wato very fine sandy loam, 7 to 12 percent slopes. A representative mapping unit is in the SW1/4NE1/4NE1/4 section 3, T. 2 N., R. 14 E. This soil is on ridgetops in broad, smooth, convex areas.

Included with this soil in mapping were areas of Lickskillet, Walls Walla, Anderly, and Nansene soils. These soils make up about 10 percent of the unit.

Runoff is medium. The hazard of water erosion is moderate. Capability unit IIIe-6; Rolling Hills range site.

55D-Wato very fine sandy loam, 12 to 20 percent north slopes. A representative mapping unit is

in the NE1/4NE1/4NW1/4, section 32, T. 2 N., R. 14 E. This soil is in long, broad, convex areas.

Included with this soil in mapping were areas of Lickskillet, Walla Walla, Anderly, and Nansene soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-4; Droughty North Exposure range site.

55E-Wato very fine sandy loam, 20 to 35 percent north slopes. A representative mapping unit is in the NE1/4SE1/4NW1/4, section 31, T. 2 N., R. 14 E. This soil is in long, narrow, broad, irregularly shaped areas.

Included with this soil in mapping were areas of Lickskillet, Walla Walla, Anderly, and Nansene soils. These soils make up as much as 16 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability unit IVe-3 ; North Exposure range site.

Wind River Series

The Wind River series consists of well drained soils formed in old alluvium on uplands. Slopes are 0 to 30 percent. Elevation is 200 to 800 feet. In uncultivated areas, the vegetation is Douglas-fir, ponderosa pine, Oregon white oak, forbs, and shrubs. The average annual precipitation is 20 to 30 inches, the average annual air temperature is 49° to 52° F, and the frost-free period is 150 to 180 days at 32° and 180 to 210 days at 28°.

In a representative profile the surface layer is very dark grayish brown fine sandy loam about 10 inches thick. The subsoil is dark brown fine sandy loam about 34 inches thick. The substratum is dark yellowish brown sandy loam to a depth of 60 inches or more. Depth to bedrock is more than 60 inches. The soil material in the profile ranges from medium acid to neutral.

Permeability is moderately rapid, and the available water capacity is 7 to 8 inches. Water-supplying capacity is 10 to 14 inches. Effective rooting depth is more than 60 inches.

These soils are used for fruit orchards, pasture, range, and wildlife habitat.

Representative profile of Wind River fine sandy loam, 0 to 8 percent slopes, 400 feet north of Old Columbia River Highway in the NW1/4SE1/4NW1/4 section 6, T. 2 N., R. 12 E..

Ap1-0 to 6 inches; very dark grayish brown (10YR 3/2) fine sandy loam, brown (10YR 5/3) dry; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; medium acid; abrupt smooth boundary.

Ap2-6 to 10 inches, very dark grayish brown (10YR 3/2) fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular and tubular pores; slightly acid; gradual smooth boundary.

B2-10 to 17 inches; dark brown (7.5YR 3/3) fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; few fine tubular pores; neutral; gradual smooth boundary.

B3-17 to 44 inches; dark brown (7.5YR 3/4) fine sandy loam, brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine tubular pores; few 1 to 6 centimeter nodules; neutral; gradual smooth boundary.

C1-44 to 61 inches; dark yellowish brown (10YR 4/4) sandy loam, brown (10YR 5/4) dry; massive, slightly hard, friable, nonsticky and nonplastic; common very fine roots; neutral; clear wavy boundary.

The A horizon is brown, grayish brown, or dark grayish brown when dry and very dark grayish brown, very dark brown, or dark brown moist. It is fine sandy loam or sandy loam. The B horizon is brown, grayish brown, or dark grayish brown when dry and very dark grayish brown, very dark brown, or dark brown moist. It is fine sandy loam, loam, or sandy loam. It has weak coarse prismatic or weak coarse or medium subangular blocky structure. The C horizon is yellowish brown, brown, or light yellowish brown when dry and dark yellowish brown or brown moist. It is fine sandy loam, sandy loam, loamy fine sand, or sand and is 0 to 20 percent rock fragments 2 to 5 millimeters in diameter.

56B-Wind River fine sandy loam, 0 to 8 percent slopes. A representative mapping unit is m the NW1/4SE1/4NW1/4 section 6, T. 2 N., R. 12 E. This soil is on ridgetops in broad, irregularly shaped areas. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Chenoweth and Van Horn soils. These soils make up about 10 percent of the unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IIe-l; Pine-Oak-Fescue range site.

56C-Wind River fine sandy loam, 8 to 12 percent slopes. A representative map ping unit is in the NE1/4NE1/4NW1/4 section 6, T. 2 N., R. 12 E. This soil is on ridgetops in broad, irregularly shaped areas.

Included with this soil in mapping were areas of Chenoweth and Van Horn soils. These soils make up about 10 percent of the unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe-2; Pine-Oak-Fescue range site.

56D-Wind River fine sandy loam, 12 to 30 percent slopes. A representative mapping unit is in the SE1/4SE1/4SE1/4 section 1, T. 2 N., R. 11 E. This soil is in long, narrow, irregularly shaped areas.

Included with this soil in mapping were areas of Chenoweth and Van Horn soils. These soils make up about 10 percent of the unit.

Runoff is medium to rapid, and the hazard of erosion is moderate to severe. Capability unit IVe-1; Pine-Oak Fescue range site.

Wrentham Series

The Wrentham series consists of well drained soils formed in loess and basalt colluvium on uplands. Slopes are 35 to 70 percent. Elevation is 1,500 to 3,600 feet. The vegetation is bunchgrasses forbs, and shrubs. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 45° to 62° F, and the frost-free period is 60 to 100 days at 32° and 100 to 150 days at 28°.

In a representative profile the surface layer is very dark brown silt loam about 18 inches thick. The upper

3 inches of the subsoil is dark brown heavy silt loam, and the lower 17 inches is dark brown very cobbly silty clay loam. Basalt bedrock is at a depth of about 38 inches. The soil material in the profile is mainly neutral, but the lower part of the subsoil is mildly alkaline.

Permeability is moderately slow, and the available water capacity is 2.5 to 7 inches. Water-supplying capacity is 6 to 8 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for range, wildlife habitat, and water supply.

representative profile of Wrentham silt loam in an area of Wrentham-Rock outcrop complex, 35 to 70 percent slopes, 20 feet north of Sinamox Road in the SE1/4SE1/4 section 28, T. 2 S., R. 15 E.:

A11-0 to 5 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak very thin platy and weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; few fine and very fine irregular pores; 5 percent pebbles and 5 percent cobbles; neutral; clear smooth boundary.

A12-6 to 10 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; 6 percent pebbles and 5 percent cobbles; neutral; clear smooth boundary.

A13-10 to 18 inches; very dark brown (10YR 2/2 silt loam, dark brown (10YR 4/3) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slight sticky and slightly plastic; many very fine roots; many very Pine tubular pores; 10 percent pebbles and 6 percent cobbles; neutral; gradual smooth boundary.

B1-I8 to 21 inches; dark brown (7.5YR 3/3) heavy silt loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 10 percent pebbles and 6 percent cobbles; neutral; gradual smooth boundary

B21-21 to 32 inches; dark brown (7.5YR 3/3) very cobbly light silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; many very fine tubular pores; thin clay films on ped surfaces; 26 percent pebbles and 26 percent cobbles; neutral; gradual smooth boundary.

B22-32 to 38 inches; dark brown (7.5YR 3/4) very cobbly silty clay loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; hard, firm, sticky, plastic; few very fine roots; many very fine tubular pores; 25 percent pebbles and 40 percent cobbles; 50 to 86 percent basalt fragments 1 to 12 inches in diameter; mildly alkaline; abrupt wavy boundary.

IIR-38 inches; basalt bedrock.

The A horizon is very dark brown or very dark grayish brown when moist. It is 0 to 25 percent coarse fragments, by volume. The B horizon is *very* dark brown or dark brown when moist. It is heavy silt loam, light silty clay loam, or silty clay loam. It is 18 to 30 percent clay and 50 to 86 percent rock fragments. Depth to basalt bedrock is 20 to 40 inches.

57F-Wrentham-Rock outcrop complex, 35 to 70 percent slopes. A representative ma ping unit is in the SE1/4SE1/4NE1/4 section 28, T. 2 S., r. 15 E. This complex is about 50 to 85 percent Wrentham silt loam and 10 to 35 percent Rock outcrop. It is in long, narrow areas and has north-facing slopes (fig. 7). The Wrentham soil has the profile described as representative of the series.

Included with this complex in mapping were areas of Cantala, Condom Bakeoven, and Lick Lickskillet soils. These soils make up as much as 15 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. Capability subclass VIIs ; Wrentham soil in Steep North range site. Rock outcrop not in a range site.

Use and Management o f the Soils

In this section some principles for the management of cropland are described, the soils are grouped into capability units according to the capability classification used by the Soil Conservation Service, yields of principal crops are estimated, and the management of soils when used for range, woodland and windbreaks, wildlife, recreational development, and engineering is discussed.

Crops and Pasture

Under the grain-fallow system of farming used in the survey area, the major management needs are controlling erosion, conserving moisture, preserving soil structure and tilth, maintaining the organic-matter content and the supply of plant nutrients, using proper silage, managing crop residues, using a suitable cropping system, controlling annual and perennial weeds, and using commercial fertilizer and amendments as needed. Soils that have slopes of more than 7 percent require intensive conservation practices to keep annual soil losses less than about 4 or 5 tone per acre. Each field needs to be evaluated for the best combination of alternative treatments to control erosion and maintain crop yields. Irrigated cropland needs proper irrigation management and soil protection against erosion. Onsite technical assistance is available from the Soil Conservation Service.

Management needs

Different soils require different treatments, and the same soil may require different treatment from year to year or from crop to crop. The basic management needs for grain summer fallow are described in the following paragraphs.

Conserving moisture.-Many cultivated soils in Wasco County, Oregon. Northern Part, are limited in productivity because of inadequate moisture. It is important, therefore, to conserve and use efficiently all available moisture. During the fallow season, evaporation losses can be kept to a minimum by maintaining a cloddy surface mulch and tilling only enough to control weeds.

Controlling erosion. -This is a most urgent need. Many of the soils are shallow or only moderately deep. Further erosion reduces the ability of the soils to store moisture and supply nutrients, and continued erosion so reduces their productivity that in time they are suitable only for low-producing range or pasture. Erosion

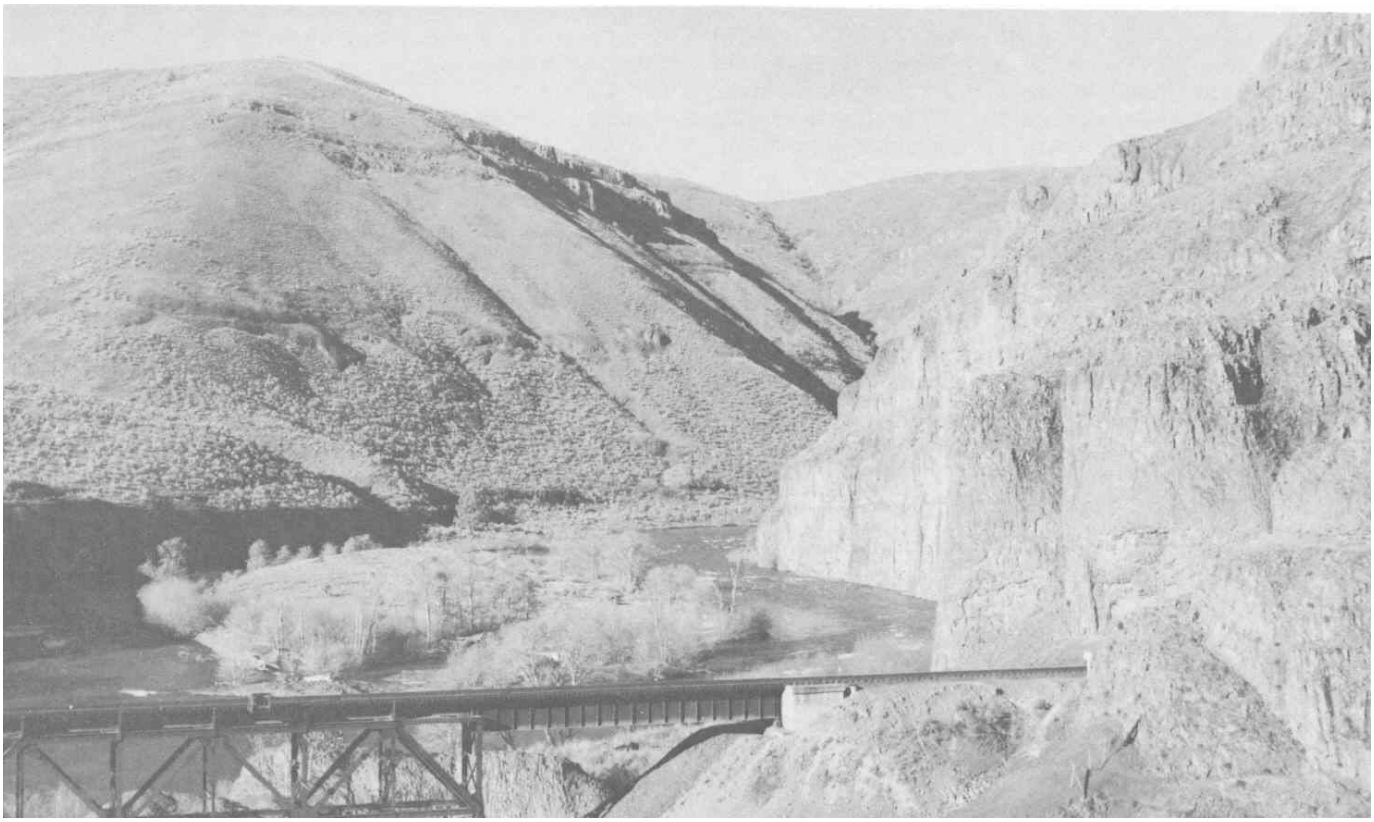

Figure 7: The north-facing soil is Wrentham-Rock outcrop complex, 35 to 70 percent slopes (mostly on right side of hill in center of background), the land on the right is Rock outcrop-Rubble land complex, and the south-facing soil is Lickskillet extremely stony loam, 40 to 70 percent slopes (mostly on left side of hill in center of background). The

reduces yields and results in sedimentation downstream. Minimum or cloddy tillage, maintenance of organic-matter content, preservation of soil structure, and installation of such practices as diversions and grassed waterways help to control erosion.

Preserving soil structure.-Proper tillage and maintenance of the organic-matter content are the two principal factors in preserving soil structure. Excessive tillage while the soil is fallow tends to destroy organic matter and soil aggregates. This reduces the free movement of water, air, and roots through the soil.

Maintaining organic-matter content: Organic matter is the partly decomposed remains of plants and soil organisms. The organic-matter content of the surface layer of the soils of the survey area ranges from a high of 3 or 4 percent under native plant cover to a low of 1 or 2 percent after a long period of cultivation.

Organic matter binds soil particles together in aggregate and thus helps to preserve soil structure. It is the source of most of the available nitrogen in the soil and also supplies other plant nutrients, such as phosphorus and sulfur. The decomposition of organic matter releases nutrients in a form available to plants.

The organic matter in the soil is constantly decomposing. Therefore, the supply must be renewed regularly and often. An adequate supply can be maintained by:

1. Returning all crop residues to the soil. Crop residues are the main source of organic matter. The organic matter is lost if residues are burned or otherwise destroyed or removed.
2. Using commercial fertilizers to balance plant and soil organism requirements in relation to available moisture.
3. Growing grass and legumes in a rotation.

Supplying plant nutrients.-Nitrogen fertilizer is used on all but the driest and shallowest cultivated soils in the survey area. Sulfur is used on about one-third of the dryfarmed areas and on all irrigated crops, particularly alfalfa. Phosphate fertilizers are used on most irrigated soils but only in a minor amount on dry-

farmed soils. Boron is commonly needed for good alfalfa production. Most other plant nutrients are adequate. Soil tests and Oregon State University fertilizer guides are available and useful for specific crops.

Weed control.-Mechanical and chemical control of annual and perennial weeds are widely used. A persistent weed control program is needed. Control of cheatgrass, grain, rye, and morning glory is especially important.

Providing proper irrigation water management. Better water management by sprinkler irrigation can be accomplished by rough leveling to eliminate pockets, sharp breaks, and other irregularities. Properly designed and operated sprinkler systems are essential to good water management. Such soil properties as intake rate, available water capacity, and permeability are important for properly designed systems. Leveling is needed on all soils before surface irrigation. If soils are properly leveled, water moves quickly and evenly over a field and wets the root zone to a uniform depth. Properly designed ditches and structures are essential to uniform water distribution. After the first leveling, floating is needed periodically to eliminate high spots and fill low spots, so that crops can be irrigated uniformly without wasting water. Ordinarily, several years of floating are required before a field is properly leveled and distribution of water is fast and efficient.

Cropping systems

A cropping system can be a regular rotation of different crops, in which the crops follow each other in a definite order, or it can consist of only one crop grown year after year. The number and variety of cropping systems in the survey area are limited by the low precipitation and the shortage of irrigation water. The principal cropping system is grain and fallow. Another dryfarmed cropping system is grass or grass and alfalfa rotated with grain or grain and fallow.

Fallow cropping system.-Most of the cropland in the survey area is used for summer-fallow grain farming. In summer-fallow dryfarming, the soil is kept free of vegetation during one crop season in order to store additional moisture for the growth and yield of a crop the following season. This practice also helps to control weeds and conserves plant nutrients.

The most common method of fallowing is to leave crop stubble standing during the winter. The soil is tilled in February, March, or April, before the weeds have removed much of the moisture and before the surface layer becomes too dry. Tillage is also performed during the summer to keep the soil free of weeds and to prepare a seedbed for fall planting.

Only about a third of the precipitation that occurs during a 2-year period is utilized by crops. Water losses through evaporation from fallow soils are high, and in certain years runoff is rapid because of slow infiltration on finely tilled seedbeds or frozen ground.

Grass-Legume rotation.-A small acreage in the survey area is utilized for a rotation of grass and legume. with grain and fallow. This rotation is used to improve fertility, increase the rate of water infiltration, ant reduce soil erosion.

Grasses and legumes can be used for rotation hay or pasture. Grasses and legumes seeded on summer-fallow or in spring of the stubble year generally can be used for forage the second year.

Plowing up the grass-legume sod and rotating to other fields needs to be done at about the time of maximum root growth. Experiments at the Sherman Branch Experiment Station show maximum root growth of suited species is reached in about 4 years. Soils used for grass-legume rotations are plowed in 4 or 5 years and then reseeded to grain.

A successful grass-legume seeding depends on a firm seedbed, a suitable seed mixture, and proper seeding. The success of the rotation depends on fitting the rotation in with other rotations on the rest of the farm. Recommendations for grass-legume varieties and seeding rates are available from the County Extension Agent and the Soil Conservation Service.

Irrigated cropping systems.-Chenoweth, Cherryhill, Van Horn, Walls Walla, and Wind River soils adjacent to the Columbia River are suited to apples, peaches, apricots, and sweet cherries. Irrigation water is provided by wells and from the Columbia River.

Cover crops are grown in orchards to control erosion. Suitable cover crops are barley or wheat, alone or grown with a legume, such as hairy vetch, common vetch, or peas. The cover crop is disked or mowed in the spring to conserve moisture, and enough residue is left on the surface to control erosion.

The acreage in irrigated hay and pasture has increased during the past 10 years. Irrigated forage is grown along the bottom lands adjacent to streams or in areas where wells or irrigation dams have been constructed.

Alfalfa is the principal legume grown for hay. It is grown alone or in combination with suitable grasses. Yields are good throughout a wide range of conditions. Seed mixtures for hay or pasture are provided by the Extension Service and the Soil Conservation Service.

Good stands, adequate irrigation and fertilization, and controlled grazing are essential for high yields of pasture crops and hay. Sulfur is needed annually on alfalfa. Soil tests can be made to determine the need for phosphorus and boron. Irrigated grass pastures need nitrogen fertilizer each year. Irrigated grass-legume pastures may need sulfur and phosphorus.

Management of grazing is essential for high yields. Good management increases yields, reduces selective grazing, cuts forage wastes, and controls the quality of the forage. Pastures can be divided, and grazing rotated every 2 to 4 days in several pastures to allow 3 to 4 weeks of regrowth.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field trope. The soils are grouped according to their limitations when used for field crops, the rink of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change elope, depth, or other characteristics of the soils; does not

take into consideration possible but unlikely major reclamation projects; and does not apply to some crops that require 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, the kinds of soils are grouped at three levels: the capability class, the subclass, and the 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 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 ants, 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 habitat. (None in survey area.)

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

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

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, water supply, or 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, IIw. The letter *e* indicates that the main limitation is risk of erosion; *w* 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* that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, 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. Class V can contain, at the most, only the subclasses indicated by w, s, and c, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

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 similar 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, IIw-1 or IIIe-2. 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. In this survey, only the cultivated soils are grouped at three levels. The noncultivated soils are grouped at two levels, in capability subclasses.

In the following pages the capability unite in the survey area are described. The names of soil series represented in a capability unit are given in the description of the capability unit, but this does not mean that all the soils of a given aeries appear in the unit. To find the capability unit or subclass in which a soil has been placed, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1

This capability unit consists of soils in the Endersby and Hermiston series. These soils are somewhat excessively drained or well drained loams and silt loams. Slopes are 0 to 3 percent. The annual precipitation is 10 to 14 inches. The frost-free period is 130 to 180 days at 32° F and 180 to 200 days at 28 .

Permeability is moderate or moderately rapid, and the available water capacity is 6.6 to 12.6 inches. Water-supplying capacity is 8 to 13 inches. Typically, roots penetrate to a depth of 40 to more than 60 inches. Runoff is slow, and the hazard of erosion is alight.

These soils are used for irrigated crops and wildlife habitat.

Irrigated alfalfa or alfalfa and grass is grown for hay, which is used for sale or winter feed. Some haylands are used for aftermath grazing in the fall. However, grazing is generally avoided to maintain the vigor of alfalfa. Hay is generally grown 6 to 8 years, and grain is grown the next year. Alfalfa generally needs annual application of sulfur or gypsum and, on some fields, phosphorus and boron. Soil teats can determine amounts needed. The first cutting of alfalfa should be at the full bud stage, the second cutting at the 1/10 to 1/2 bloom stage, and the third cutting 4 to 6 weeks before the last killing frost.

Irrigation water is available from streamflow until late in June but in several areas dams impound water for use throughout the summer. Irrigation methods include sprinkler, border, contour furrow, and wild flooding.

CAPABILITY UNIT IIe-1

This capability unit consists of soils in the Chenoweth, Cherryhill, Van Horn, and Wind River aeries. These soils are well drained fine sandy loams, silt

loams, and loams. Slopes are 0 to 8 percent. The annual precipitation is 14 to 30 inches. The frost-free period is 140 to 210 days at 32° F and 170 to 250 days at 28°.

Permeability is moderately rapid to moderately slow, and the available water capacity is 6.5 to 11 inches. Water-supplying capacity is 8 to 15 inches. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is slow, and the hazard of erosion is slight.

These soils are used for fruit orchards, hay, pasture, and wildlife habitat.

Cover crops are used in orchards as a source of organic matter. An annual grain or mixed grain and legume cover crop is common, but some perennials are used where irrigation water is adequate. Spring mowing or disking reduces the cover crop and conserves soil moisture. The cover crop is fertilized as follows.

For mature bearing trees, 100 pounds per acre of nitrogen is applied late in winter or early in spring in one application, 6 to 8 pounds of zinc in a spray, and 2 to 3 pounds of boron in a spray.

For trees less than 10 years old, 1/4 pound of nitrogen per tree is applied in a split application late in winter or early in spring and a second application in June.

Irrigated cherries commonly are planted in a diamond pattern. The trees are spaced 30 feet by 30 feet, and 56 trees can be planted per acre. Only 48 trees per acre can be planted in a square pattern at the same spacing.

Systematic pruning is practiced. Harvesting is mostly done by hand. Rigorous and timely spraying for cherry fruit fly and other insects and diseases is necessary.

CAPABILITY UNIT II-2

This capability unit consists of soils in the Maupin, Maupin variant, Watama, and Wapinitia series. These soils are well drained silt loams and loams. Slopes are 0 to 5 percent. The annual precipitation is 10 to 16 inches. The frost-free period is 120 to 170 days at 32° F and 170 to 200 days at 28 .

Permeability is moderate or moderately slow, and the available water capacity is 3 to 12 inches. Water-supplying capacity is 6 to 14 inches. Typically, roots penetrate to a depth of 20 to 60 inches. Runoff is slow, and the hazard of erosion is slight.

These soils are used for irrigated hay, pasture, grain, and wildlife habitat.

Irrigated alfalfa or alfalfa and grass is grown for hay, which is used for sale or winter feed. Some haylands are used for aftermath grazing in the fall. However, grazing is generally avoided to maintain the vigor of alfalfa. Hay is generally grown 5 to 8 years, and then grain is grown the next year. Alfalfa generally needs annual application of sulfur or gypsum and, on some fields, phosphorus and boron. Soil tests can determine amounts needed. The first cutting of alfalfa should be done at the full bud stage, the second cutting at the 1/10 to 1/2 bloom stage, and the third cutting 4 to 6 weeks before the last killing frost.

Irrigation water is available from streamflow until late in June, but in several areas dams impound water for use throughout the summer. Good irrigation water management is important. Irrigation methods include sprinkler, border, contour furrow, and wild flooding. Some fields adjoining streams need streambank protection.

CAPABILITY UNIT IIe-3

This capability unit consists of soils in the Cantala, Dufur, Endersby, Hermiston, Maupin, Maupin variant, Walla Walla, Watama, and Wapinitia series. These soils are somewhat excessively drained and well drained silt loams and loams. Slopes are 0 to 7 percent. The annual precipitation is 10 to 14 inches. The frost-free period is 100 to 170 days at 32° F and 150 to 210 days at 28°.

Permeability is moderate, and the available water capacity is 7 to 15 inches. Water-supplying capacity is 5 to 13 inches. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is slow, and the hazard of erosion is slight.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

A grain-fallow system of dryfarming is commonly used. In the fallow year a seedbed is prepared in the spring by plowing or by using disks, sweeps, or chisels. Weeds are controlled and soil moisture is retained through the use of rod weeders. Nitrogen fertilizer is applied in the fallow year. Sulfur is needed on some soils.

Several winter wheat varieties are suitable. Early fall seeding provides extra cover and helps reduce water erosion during the winter. At higher elevations early fall seeding is needed to ensure a stand. Annual broadleaf weeds are generally controlled in the fall or spring depending on weather, crops, and weed size. Perennial weeds are controlled by use of chemicals and mechanical practices. Grain is harvested in bulk, and the straw is scattered or dumped.

Straw scattering at harvest is helpful in erosion control. Cloddy fallow and minimum tillage increases water intake and reduces soil erosion.

CAPABILITY UNIT II-1

The only soil in this capability unit is Pedigo silt loam. It is a somewhat poorly drained soil. Slopes are 0 to 3 percent. The annual precipitation is 10 to 13 inches. The frost-free period is 130 to 180 days at 32° F and 180 to 200 days at 28°.

Permeability is moderate, and the available water capacity is 10 to 11 inches. Water-supplying capacity is 9 to 13 inches. Typically, roots penetrate to a depth of more than 60 inches. Runoff is, slow, and the hazard of erosion is slight.

This soil is used for irrigated hay, pasture, dryfarmed grain, and wildlife habitat.

Irrigated alfalfa or alfalfa and grass is grown for hay, which is used for sale or winter feed. Some haylands are used for aftermath grazing in the fall. However, grazing is generally avoided to maintain the vigor of alfalfa. Hay is generally grown for 5 to 8 years and

then grain is grown the next year. Alfalfa generally needs annual application of sulfur or gypsum and, on some fields, phosphorus and boron. Soil tests can determine amounts needed. The first cutting of alfalfa should be done at the full bud stage, the second cutting at 1/10 to 1/2 bloom stage, and the third cutting 4 to 6 weeks before the last killing frost.

Irrigation water is available from streamflow until late in June, but in several areas dams impound water for use throughout the summer. Good irrigation water management is important. Irrigation methods include sprinkler, border, contour furrow, and wild flooding. Some fields adjoining streams need streambank protection.

A grain-fallow system of dryfarming is commonly used. In the flow year a seedbed is prepared in the spring by plowing or by using disks, sweeps, or chisels. Weeds are controlled and soil moisture is retained through the use of rod weeders. Nitrogen fertilizer is applied in the fallow year. Sulfur is needed in some soils.

Several winter wheat varieties are suitable. Annual broadleaf weeds are generally controlled in the fall or spring depending on weather, crops, and weed size. Perennial weeds are controlled by use of chemicals and mechanical practices. Grain is harvested in bulk, and the straw is scattered or dumped.

CAPABILITY UNIT IIIe-1

This capability unit consists of soils in the Cantala, Dufur, Walla Walla, and Wamic series. These soils are well drained silt roams and loams. Slopes are 1 to 12 percent. The annual precipitation is 10 to 14 inches. The frost-free period is 100 to 170 days at 32° F and 160 to 210 days at 28°.

Permeability is moderate or moderately slow, and the available water capacity is 6 to 12 inches. Water-supplying capacity is 8 to 12 inches. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is slow or medium, and the hazard of erosion is slight or moderate.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

A grain-fallow system of dryfarming is commonly used. In the flow year a seedbed is prepared in the spring by plowing or by using disks, sweeps, or chisels. Weeds are controlled and soil moisture is retained through the use of rod weeders. Nitrogen fertilizer is applied in the fallow year. Sulfur is needed on some soils.

Several winter wheat varieties are suitable. Early fall seeding provides extra cover and helps reduce water erosion during the winter. At higher elevations early fall seeding is needed to ensure a stand. Annual broadleaf weeds are generally controlled in the fall or spring depending on weather, crops, and weed size. Perennial weeds are controlled by use of chemicals and mechanical practices. Grain is harvested in bulk, and the straw is scattered or dumped.

Straw scattering at harvest, cloddy fallow and minimum tillage, and contour farming are needed to keep soil erosion losses to less than about 4 to 6 tons per acre per year.

CAPABILITY UNIT IIIe-2

This capability unit consists of soils in the Chenoweth, Cherryhill, Van Horn, and Wind River series. These soils are well drained silt roams, fine sandy roams, and loams. Slopes are 7 to 20 percent. The annual precipitation is 14 to 30 inches. The frost-free period is 140 to 210 days at 32° F and 170 to 260 days at 28°.

Permeability is moderately rapid to moderately slow, and the available water capacity is 7 to 11 inches. Water-supplying capacity is 8 to 15 inches. Typically, roots penetrate to a depth of 40 to 60 inches or more. Runoff is medium, and the hazard of erosion is moderate.

These soils are used for fruit orchards, hay, pasture, and wildlife habitat.

Cover crops are used in orchards for erosion control and as a source of organic matter. An annual grain or mixed grain and legume cover crop is common, but some perennials are used where irrigation water is adequate. Spring mowing or disking reduces the cover crop and conserves soil moisture. The cover crop is fertilized as follows.

For mature bearing trees, 100 pounds per acre of nitrogen is applied late in winter and early in s ring in one application, 6 to 8 pounds of zinc in a spray, and 2 to 3 pounds of boron in a spray.

For trees less than 10 years old, 1/4 pound of nitrogen per tree is applied in a split application late in winter or early in spring and a second application in June.

Irrigated cherries are commonly planted in a diamond pattern. The trees are spaced 30 feet by 30 feet, and 66 trees can be planted per acre. Only 48 trees per acre can be planted in a square pattern at the same spacing.

Systematic pruning is practiced. Harvesting is mostly done by hand. Rigorous and timely spraying for cherry fruit fly and other insects and diseases is necessary.

CAPABILITY UNIT IIIe-3

The only soil in this capability unit is Sinamox silt loam, 1 to 7 percent slopes. It is a well drained soil. The annual precipitation is 10 to 12 inches. The frost-free period is 120 to 170 days at 32° F and 170 to 200 days at 28°.

Permeability is moderately slow, and the available water capacity is 5 to 11 inches. Water-supplying capacity is 6 to 9 inches. Typically, roots penetrate to a depth of 40 to more than 60 inches. Runoff is slow, and the hazard of erosion is slight.

This soil is used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

A grain-fallow system of dryfarming is commonly used. In the fallow year a seedbed is prepared in spring by plowing or by using disks, sweeps, or chisels. Weeds are controlled and soil moisture is retained through the use of rod weeders. Nitrogen fertilizer is applied in the fallow year. Sulfur is needed on some soils.

Several winter wheat varieties are suitable. Early fall seeding provides extra cover and helps reduce

water erosion during the winter. At higher elevations early fall seeding is needed to ensure a stand. Annual broadleaf weeds are generally controlled in fall or spring depending on weather, crops, and weed size. Perennial weeds are controlled by use of chemicals and mechanical practices. Grain is harvested in bulk, and the straw is scattered or dumped.

Straw scattering at harvest, clod fallow and minimum tillage, and contour farming are needed to keep soil erosion losses to less than about 4 or 5 tons per acre per year.

CAPABIUTY UNIT IIIe-4

This capability unit consists of soils in the Cantala, Dufur, Walla Walla, Wamic, Watama, Wapinitia, and Wato series. These soils are well drained silt loams, loams, and very fine sandy loams. The frost-free period is 100 to 170 days at 32° F.

Permeability is moderately rapid to moderately slow, and the available water capacity is 6 to 12 inches. Water-supplying capacity is 6 to 14 inches. Typically, roots penetrate to a depth of 20 to more than 60 inches. Runoff is medium, and the hazard of erosion is moderate.

These soils are used for dryfarmed small grain, hay, pasture, and wildlife habitat.

A grain-fallow system of dryfarming is commonly used. In the fallow year a seedbed is prepared in the spring by plowing or by using dikes, sweeps, or chisels. Weeds are controlled and soil moisture is retained through the use of rod weeders. Nitrogen fertilizer is applied in the fallow year. Sulfur is needed on some soils.

Several winter wheat varieties are suitable. Early fall seeding provides extra cover and helps reduce water erosion during the winter. Annual broadleaf weeds are generally controlled in the fall or spring depending on weather, crops, and weed size. Perennial weeds are controlled by use of chemicals and mechanical practices. Grain is harvested in bulk, and the straw is scattered or dumped.

Combinations of straw scattering at harvest, cloddy fallow and minimum tillage, diversion terraces where slopes are as much as 18 percent, contour farming, and as much as 1,700 pounds of crop residue per acre on the soil surface during winter are needed to keep soil erosion losses to less than about 4 or 5 tons per acre per year.

CAPABILITY UNIT IIIe-5

This capability unit consists of soils in the Anderly, Condom Duart, Maupin, Sinamox, Wamic, and Wapinitia variant series. These soils are well drained loams and silt loams. Slopes are 1 to 20 percent. The annual precipitation is 10 to 20 inches. The frost-free period is 100 to 170 days at 32° F.

Permeability is slow to moderate, and the available water capacity is 3 to 11 inches. Water-supplying capacity is 6 to 13 inches. Typically, roots penetrate to a depth of 20 to more than 60 inches. Runoff is slow or medium, and the hazard of erosion is slight or moderate.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

A grain-fallow system of dryfarming is commonly used. In the fallow year a seedbed is prepared in the spring by plowing or by using disks, sweeps, or chisels. Weeds are controlled and soil moisture is retained through the use of rod weeders. Nitrogen fertilizer is applied in the fallow year. Sulfur is needed on some soils.

Several winter wheat varieties are suitable. Early fall seeding provides extra cover and helps reduce water erosion during the winter. At higher elevations early fall seeding is needed to ensure a stand. Annual broadleaf weeds are generally controlled in the fall or spring depending on weather, crops, and weed size. Perennial weeds are controlled by use of chemicals and mechanical practices. Grain is harvested in bulk, and the straw is scattered or dumped.

Combinations of straw scattering at harvest, clod fallow and minimum tillage, diversion terraces, contour farming, and as much as 1,000 pounds of crop residue per acre on the soil surface during winter are needed to keep soil erosion losses to less than about 4 or 5 tons per acre per year.

CAPABILITY UNIT IIIe-6

This capability unit consists of soils in the Wato series. These soils are well drained very fine sandy loam. Slopes are 3 to 12 percent. The annual precipitation is 12 to 14 inches. The frost-free period is 150 to 170 days at 32° F and 170 to 210 days at 28 .

Permeability is moderately rapid, and the available water capacity is 6 to 10 inches. Water-supplying capacity is 7 to 10 inches. Typically, roots penetrate to a depth of 40 to more than 60 inches. Runoff is slow or medium. The hazard of water erosion is slight or moderate, and the hazard of soil blowing is moderate. Some areas are moderately eroded.

These soils are used for dryfarmed small grain, hay, pasture, and wildlife habitat.

A grain-fallow system of dryfarming is commonly used. In the fallow year a seedbed is prepared in the spring by plowing or by using disks, sweeps, or chisels. Weeds are controlled and soil moisture is retained through the use of rod weeders. Nitrogen fertilizer is applied in the fallow year. Sulfur is needed on some soils.

Several winter wheat varieties are suitable. Early fall seeding provides extra cover and helps reduce water erosion during the winter. Annual broadleaf weeds are generally controlled in the fall or spring depending on weather, crops, and weed size. Perennial weeds are controlled by use of chemicals and mechanical practices. Grain is harvested in bulk, and the straw is scattered or dumped.

Combinations of straw scattering at harvest, cloddy fallow and minimum tillage, diversion terraces, contour farming, and about 1,000 pounds of crop residue per acre on an established crop are needed on the soil surface at all times to keep water erosion and soil blowing losses to less than about 4 or 5 tons per acre per year.

CAPABILITY UNIT IIIe-7

This capability unit consists of soils in the Anderly and Sinamox series. These soils are well drained silt loams. Slopes are 12 to 20 percent. The annual precipitation is 10 to 14 inches. The frost-free period is 120 to 170 days at 32° F and 170 to 210 days at 28 .

Permeability is moderate or moderately slow, and the available water capacity is from 3 to 11 inches. Water-supplying capacity is 6 to 9 inches. Typically, roots penetrate to a depth of 20 to more than 60 inches. Runoff is medium, and the hazard of erosion is moderate.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

A grain-fallow system of dryfarming is commonly used. In the fallow year a seedbed is prepared in the spring by plowing or by using disks, sweeps, or chisels. Weeds are controlled and soil moisture is retained through the use of rod weeders. Nitrogen fertilizer is applied in the fallow year. Sulfur is needed on some soils.

Several winter wheat varieties are suitable. Early fall seeding provides extra cover and helps reduce water erosion during the winter. Annual broadleaf weeds are generally controlled in the fall or spring depending on weather, crops, and weed size. Perennial weeds are controlled by use of chemicals and mechanical practices. Grain is harvested in bulk, and the straw is scattered or dumped.

Combinations of straw scattering at harvest, cloddy fallow and minimum tillage, diversion terraces, contour farming, as much as 2,100 pounds of crop residue per acre on the soil surface over winter, or conversion to permanent pasture or hay are needed to keep soil erosion losses to less than about 4 or 5 tons per acre per year.

CAPABILITY UNIT IIIw-1

This capability unit consists of soils in the Quincy and Tygh series. These soils are loamy fine sands and fine sandy loams. They are subject to seasonal flooding or have a water table at a depth of 40 to 60 inches. Slopes are 0 to 3 percent. The annual precipitation is 10 to 20 inches. The frost-free period is 120 to 170 days at 32° F and 150 to 200 days at 28°.

Permeability is rapid or moderately rapid, and the available water capacity is 3 to 8 inches. Water-supplying capacity is variable and depends upon depth to the water table. Typically, roots penetrate to a depth of 40 to more than 60 inches. Runoff is slow, and the hazard of erosion is slight.

These soils are used for irrigated grain, hay, pasture, dryfarmed grain, and wildlife habitat.

Irrigated alfalfa or alfalfa and grass is grown for hay, which is used for sale or winter feed. Some haylands are used for aftermath grazing in the fall. However, grazing is generally avoided to maintain the vigor of alfalfa. Hay is generally grown for 5 to 8 years, and then grain is grown the next year. Alfalfa needs annual application of sulfur or gypsum and, on some fields, phosphorus and boron. Soil tests can determine amounts needed. The first cutting of alfalfa should be at the full bud stage, the second cutting at the 1/10 to 1/2 bloom stage, and the third cutting 4 to 6 weeks before the last killing frost.

Irrigation water is available from streamflow until late in June, but in several areas dams impound water for use throughout the summer. Good irrigation water management is important. Irrigation methods include sprinkler, border, contour furrow, and wild flooding. Some fields adjoining streams need. streambank protection, and some fields need protection against flooding. A water table confines roots to a depth of less than 40 to 60 inches unless additional drainage is provided.

A grain-fallow system of dryfarming is commonly used. In the fallow year a seedbed is prepared in the spring by plowing or by using disks, sweeps, or chisels. Weeds are controlled and soil moisture is retained through the use of rod weeders. Nitrogen fertilizer is applied in the fallow year. Sulfur is needed on some soils.

Several winter wheat varieties are suitable. Annual broadleaf weeds are generally controlled in the fall or spring depending on weather, crops, and weed size. Perennial weeds are controlled by use of chemicals and mechanical practices. Grain is harvested in bulk, and the straw is scattered or dumped.

CAPABILITY UNIT IVe-1

This capability unit consists of soils in the Chenoweth, Cherryhill, Van Horn, and Wind River series. These soils are well drained loams, silt loams, and fine sandy loams. Slopes are 12 to 35 percent. The annual precipitation is 14 to 30 inches. The frost-free period is 140 to 210 days at 32° F.

Permeability is moderately slow to moderately rapid, and the available water capacity is 7 to 9 inches. Water-supplying capacity is 8 to 15 inches. Typically, roots penetrate to a depth of more than 60 inches. Runoff is medium or rapid, and the hazard of erosion is moderate or severe.

These soils are used for fruit orchards, pasture, range, and wildlife habitat.

Cover crops are essential in orchards for erosion control, and they also provide a source of organic matter. An annual grain or mixed grain and legume cover crop is common, but perennials are better suited for erosion control. If adequate irrigation water is available, mowing alone is sufficient to reduce the cover crop. Conservation of soil moisture is necessary in nonirrigated orchards. The cover crop is fertilized as follows.

For mature bearing trees, 100 pounds per acre of nitrogen is applied late in winter or early in spring in one application, 6 to 8 pounds of zinc in a spray, 2 to 3 pounds of boron in a spray.

For young trees less than 10 years old, 1/- pound of nitrogen per tree is applied in a split application late in winter or early in spring and a second application in June.

Irrigated cherries are commonly planted in a diamond pattern. The trees are spaced 30 feet by 30 feet, and 56 trees can be planted per acre. Only 48 trees per acre can be planted in a square pattern at the same spacing.

Systematic pruning is practiced. Harvesting is most-

ly done by hand. Rigorous and timely spraying for cherry fruit fly and other insects and diseases is necessary.

CAPABILITY UNIT IVe-2

This capability unit consists of soils in the Dufur, Walla Walla, Watama, and Wapinitia series. These soils are well drained silt loams. Slopes are 20 to 40 percent. The annual precipitation is 12 to 16 inches. The frost-free period is 120 to 170 days at 32° F and 170 to 200 days at 28°.

Permeability is moderate or moderately slow, and the available water capacity is 4 to 12 inches. Water-supplying capacity is 6 to 14 inches. Typically, roots penetrate to a depth of 20 to 60 inches. Runoff is rapid, and the hazard of erosion is severe.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

A grain-fallow system of dryfarming is commonly used. In the fallow year a seedbed is prepared in the ring by lowing or by using disks, sweeps, or chisels. Weeds are controlled and soil moisture is retained through the use of rod weeders. Nitrogen fertilizer is applied in the fallow year. Sulfur is needed on some soils.

Several winter wheat varieties are suitable. Early fall seeding provides extra cover and helps reduce water erosion during the winter. Annual broadleaf weeds are generally controlled in the fall or spring depending on weather, crops, and weed size. Perennial weeds are controlled by chemicals and mechanical practices. Grain is harvested in bulk, and the straw is scattered or dumped.

Combinations of straw scattering at harvest, cloddy fallow and minimum tillage, diversion terraces where slopes are as much as 18 percent, contour farming, and as much as 2,500 pounds of crop residue per acre on the soil surface during winter or conversion to permanent pasture or hay are needed to keep soil erosion losses to less than about 4 or 5 tons per acre per year.

CAPABILITY UNIT IVe-3

This capability unit consists of soils in the Cantata, Walla Walla, and Wato series. These soils are well drained silt loams and very fine sandy loams. Slopes are 20 to 35 percent. The annual precipitation is 10 to 14 inches. The frost-free period is 100 to 170 days at 32° F and 150 to 210 days at 28°.

Permeability is moderate or moderately rapid, and the available water capacity is 6 to 12 inches. Water-supplying capacity is 8 to 12 inches. Typically, roots penetrate to a depth of 40 to more than 60 inches. Runoff is rapid, and the hazard of erosion is severe.

These soils are used for dryfarmed small grain, hay, pasture, range, and wildlife habitat.

A grain-fallow system of dryfarming is commonly used. In the fallow year a seedbed is prepared in the spring by plowing or by using disks, sweeps, or chisels. Weeds are controlled and soil moisture is retained through the use of rod weeders. Nitrogen fertilizer is applied in the fallow year. Sulfur is needed on some soils.

Several winter wheat varieties are suitable. Early fall seeding provides extra cover and helps reduce water erosion during the winter. Annual broadleaf weeds are generally controlled in the fall or spring depending on weather, crops, and weed size. Perennial weeds are controlled by use of chemicals and mechanical practices. Grain is harvested in bulk, and the straw is scattered or dumped.

Combinations of straw scattering at harvest, cloddy fallow and minimum tillage, diversion terraces where slopes are as much as 18 percent, contour farming, and as much as 2,800 pounds of crop residue per acre on the soil surface over winter or conversion to permanent pasture or hay are needed to keep soil erosion losses to less than about 4 or 5 tons per acre per year.

CAPABILITY UNIT IVw-1

This capability unit consists of Cumulic Haplaquolls. These soils are nearly level, somewhat poorly drained, or poorly drained silt loams, loams, sandy loams, clay loams, and clays. The annual precipitation is 15 to 30 inches. The frost-free period is 100 to 180 days at 32° F and 180 to 210 days at 28 .

Permeability is moderate to slow, and the available water capacity and water-supplying capacity are variable depending upon texture and depth to water table. Typically, roots penetrate to a depth of 20 to more than 60 inches. These soils are occasionally flooded and are subject to channeling and washing. Runoff is slow, and the hazard of erosion is slight. These soils are subject to overflow and in places are ponded during months of high precipitation.

These soils are used for hay, pasture, range, and wildlife habitat.

Alfalfa and grass are grown for hay, which is used for sale or winter feed. Some haylands are used for aftermath grating in the fall. However, grazing is generally avoided to maintain the vigor of alfalfa. Hay is generally grown 5 to 8 years, and grain is grown the next year. Alfalfa generally needs an annual application of sulfur or gypsum and, on some fields, phosphorus and boron. Soil tests can determine amounts needed. The first cutting of alfalfa should be done at the full bud stage, the second cutting at the 1/10 to 1/2 bloom stage, and the third cutting 4 to 6 weeks before the last killing frost.

Irrigation water is available from streamflow until late in June, but in several areas dams impound water for use throughout the summer. Good irrigation water management is important. Irrigation methods include sprinkler, border, contour furrow, and wild flooding. Fields adjoining streams need streambank protection, and most fields need protection against flooding. A water table confines roots to a depth of less than 20 to 60 inches unless additional drainage is provided.

CAPABILITY SUBCLASS VIe

This capability subclass consists of soils in the Anderly, Bakeoven, Bins, Cherryhill, London, Duart, Frailey, Ketchly, Sherar, Sinamox, Skyline, Walla Walla, Wamic, and Warden series. These soils are well drained, and they formed in loess and volcanic ash and

in colluvium or residuum weathered from sandstone, conglomerate, and basalt. Slopes are 2 to 55 percent. The annual precipitation is 9 to 30 inches. The frost-free period is 50 to 180 days at 32° F and 90 to 200 days at 28°.

Permeability is slow to moderate, and the available water capacity is about 1 inch to 12 inches. Water-supplying capacity is 3 to 20 inches. Typically, roots penetrate to a depth of about 4 to more than 60 inches. Runoff is slow to rapid, and the hazard of erosion is slight to severe.

These soils are used for range, pasture, timber, wildlife habitat, and water supply. For use and management suggestions see the sections, "Range," "Wildlife," and "Woodland and Windbreaks."

CAPABILITY SUBCLASS VIs

This capability subclass consists of soils in the Bald and Bindle series. These soils are well drained, and they formed in volcanic ash and colluvium derived from basalt. Slopes are 1 to 45 percent. The annual precipitation is 20 to 30 inches. The frost-free period is 50 to 140 days at 32° F and 90 to 180 days at 28°.

Permeability is moderate, and the available water capacity is 2 to 7 inches. Water-supplying capacity is 12 to 20 inches. Typically, roots penetrate to a depth of 20 to 40 inches. Runoff is slow to rapid, and the hazard of erosion is slight to severe.

These soils are used for range, timber, wildlife habitat, and water supply. For use and management suggestions see the sections "Range," "Wildlife," and 'Woodland and Windbreaks."

CAPABILITY SUBCLASS VIIe

This capability subclass consists of soils in the Bins, Frailey, Ketchly, Nansene, Sherar, Sinamox, and Wamic series. These soils are well drained, and they formed in loess and volcanic ash and in colluvium or residuum weathered from sandstone, conglomerate, and basalt. Slopes are 30 to 70 percent. The annual precipitation is 10 to 30 inches. The frost-free period is 50 to 180 days at 32° F and 90 to 220 days at 28°.

Permeability is slow to moderate, and the available water capacity is 2 to 12 inches. Water-supplying capacity is 2 to 20 inches. Typically, roots penetrate to a depth of 20 to more than 60 inches. Runoff is rapid, and the hazard of erosion is severe.

These soils are used for range, timber, wildlife habitat, and water supply. For use and management suggestions see the sections "Range," "Wildlife," and "Woodland and Windbreaks."

CAPABILITY SUBCLASS VIIs

This capability subclass consists of soils in the Bakeoven, Bald, Bald variant, Bindle, Bodell, Condom Hesslan, Lickskillet, Maupin, Skyline, Watama, and Wrentham series and Rock outcrop. The soils are well drained, and they formed on uplands in loess and volcanic ash and in colluvium and residuum weathered from sandstone, and conglomerate, and basalt. Slopes range from 2 to 70 percent. The annual precipitation ranges from 10 to 30 inches. The frost-free period is 50 to 170 days at 32° F and 90 to 210 days at 28°.

Permeability is moderate or moderately slow, and the available water capacity is about 1 inch to 11 inches. Water-supplying capacity is about 3 to 20 inches. Typically, roots penetrate to a depth of about 4 to 40 inches. Runoff is slow to rapid, and the hazard of erosion is slight to severe.

These soils are used for range, timber, wildlife habitat, and water supply. For use and management suggestions see the sections "Range," "Wildlife," and "Woodland and Windbreaks."

CAPABILITY SUBCLASS VIIIe

This capability subclass consists only of Dune land. This land type consists of areas where westerly winds have drifted sand into small dunes. It is barren, and has little or no value for farming or grazing. Dune land is used for wildlife habitat.

CAPABILITY SUBCLASS VIIIs

This capability subclass consists of Rock outcrop. Rubble land complex and Rock outcrop-Xeropsamments complex. Rock outcrop-Rubble land complex consists of severely eroded areas and basalt cliffs that have stony or bouldery foot slopes. Slopes are mainly 30 to 100 percent. Rock outcrop-Xeropsamments complex is old scoured terraces along the Columbia River and consists of outcroppings of rock, sand, and gravel. Slopes are 0 to 30 percent. Most of the area is not accessible to livestock.

These complexes are used for wildlife habitat, for water supply, and as a source of material for roads and other construction.

CAPABILITY SUBSCLASS VIIIw

This capability subclass consists of Riverwash. Riverwash is subject to overflow and shifting during normal high water and has little or no value for farming.

Riverwash is used for wildlife habitat and as a source of material for roads and other construction.

Estimated yields

Table 2 shows estimated average yields per acre of selected crops for most soils in the survey area. Estimates are used on the most common combination of management practices used by most farmers and ranchers in Wasco County, Oregon, Northern Part. The estimated yields for dryfarmed wheat is for the year of harvest or every 2 years. It is based on data from Agricultural Stabilization and Conservation Service records for the determination of the 10-year cereal grain base. Most dryfarmed mapping units in the survey area are included in these records.

Estimated yields of cherries and apples are based on the records of farmers. The yield data for grass-legume hay are based on leaving a 50 percent stubble. These data are estimated from actual use records, clipping information, and observations.

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document.

Range

About 75 percent of the survey area is in two types of range, based on the sensitivity of the vegetation to climate. The western third of the survey area is dominated by Oregon white oak and coniferous trees. Oaks follow the flow of warm, moist air from the Columbia Gorge and south from The Dalles along the base of the Cascade Mountains for about 35 miles. The eastern part of the survey area is beyond this temperate influence, and bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass make up nearly 100 percent of the original plant community. South of Tygh Ridge, a more complex type of vegetation occurs. It consists of native bunchgrass, western juniper, big sagebrush, and bitterbrush. This area lies adjacent to the White River Game Management Area administered by the Oregon Wildlife Commission, and deer and elk use the area for winter range.

A significant ecological change in recent years is the increase of Oregon white oak. Because Oregon white oak sprouts following fire, it has replaced ponderosa pine in the more favorable soil areas. As a result, the original pine-oak savannahs have been replaced by young stands of "scrub" oak that now dominate much of the landscape from The Dalles south along the western portion of the survey area.

S. F. GREENFIELD, JR., range conservationist, Soil Conservation Service, helped prepare this section.

Range sites and condition classes

Soils that have the capacity to produce the same kinds, amounts, and proportions of range plants are grouped into range sites. A range site is the product of all environmental factors responsible for its development.

A plant community existing within a range site that has not undergone abnormal disturbance is the potential, or climax, plant community, for that site. Climax plant communities are not precise or fixed in their composition but vary, within reasonable limits, from year to year and from place to place.

Abnormal disturbance, such as overuse by livestock, excessive burning, erosion, or plowing, results in changes in the climax plant community or even its complete destruction if disturbance is drastic enough. When the range site has not deteriorated significantly under such disturbance, secondary plant succession

progresses in the direction of the natural potential or climax plant community for the site.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

A range is in excellent condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in good condition if the percentage is 51 to 75 ; in fair condition if the percentage is 26 to 50 ; and in poor condition if the percentage is less than 25.

When changes occur in the climax plant community due to use by livestock or disturbance, some plant species increase, others decrease. The species that increase or decrease depends upon the grazing animal, season of use, and the degree of utilization. By comparing the composition of the present plant community to the potential plant community, it is possible to see how individual species have increased while others decreased. Plants not present in the climax community which show up in the present plant community are invaders for the site.

The composition of climax and present plant communities together with other range site information provides the basis for selecting range management systems.

Management programs on range generally try to increase desirable plants and restore range to as near climax condition as possible. Some programs are designed to create or maintain plant communities somewhat removed from the climax to fit specific needs in the grazing program, to provide for wildlife habitat, or for other benefits. Any management objective should be compatible with conservation objectives.

Grazing of understory plants on forest land is compatible with timber management if it is controlled in a manner that maintains or enhances both timber and forage resources. However, there are several factors that affect forage production and grazing use. Tree spacing and canopy cover strongly influence both the composition and productivity of the understory. As the shade cast by tree canopies increases, productivity decreases and species that are not shade tolerant decrease in number or die. When forest cover is cut or burned, maximum forage production can occur for a number of years under proper treatment and management.

Environmental variations on forest land also influence plant composition and forage production. In this survey area, south-facing slopes and other less favorable tree-producing sites have good stands of forage bunchgrasses because of the more nearly open tree canopy. In the upper mountain areas, especially on north-facing slopes, the value for grazing is low because of the normally dense canopy cover and the heavy accumulation of fallen needles under the trees. Such a condition leaves only a sparse understory of shade-tolerant grasses and forbs.

Table 3 shows, for each soil, the range site; the total annual production in favorable, normal, and unfavorable years; and the names of major plant species and the percentage of each in the composition of the potential plant community.

A range site supports a distinctive potential plant community, or combination of plants, that can grow on a site that has not undergone major disturbance. Soils that produce the same kind, amount, and proportion of range plants are grouped into range sites. Range sites can be interpreted directly from the soil map where the relationships between soils and vegetation have been correlated. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on range plants and their productivity. Soil reaction, salt content, and a seasonal high water table are also important.

Potential production refers to the amount of vegetation that can be expected from a well-managed range that is supporting the potential plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. A favorable year is one in which the amount and distribution of precipitation and the temperature result in growing conditions substantial)y better than average; a normal year is one in which these conditions are about average for the area; an unfavorable year is one in which growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential plant community. All vegetation, both that which is highly palatable and that which is unpalatable to livestock, is included. Some vegetation also may be grazed extensively by wildlife and some of it may not. Plant species that have special value for livestock forage are mentioned in the description of each soil mapping unit.

Common names are listed for the grasses, orbs, and shrubs that make up most of the potential plant community on each soil. Under the heading "Composition" in table 3, the proportion of each species is presented as the percentage, in dry-weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the season when the forage is grazed. All of the vegetation produced is normally not used.

ROLLING HILLS RANGE SITE

This range site is on Anderly, Bakeoven, Cantala, Condom Duart, Dufur, Walla Walla, and Wato soils. It is in the eastern part of the survey area. These soils are well drained silt looms and very fine sandy looms that formed mostly in loess and volcanic ash on broad ridgetops and rolling uplands. They are nearly level to steep.

Elevation ranges from 300 to 3,600 feet. The average annual precipitation is 10 to 14 inches. Runoff is slow or medium, and the hazard of erosion is slight or moderate. Permeability is moderate or moderately rapid, and the water-supplying capacity is 6 to 12

inches. Roots penetrate to a depth of 20 to 60 inches or more. Major forage grasses begin to grow about March 20.

Where this site is in poor condition, big sagebrush and an understory of Sandberg bluegrass commonly increase in the stand. Bluebunch wheatgrass and Idaho fescue have been nearly eliminated. If deterioration is severe, cheatgrass, squirreltail, and annual weeds invade and dominate.

Special improvement measures are suited to most areas of this site. If the range is in fair and poor condition, spraying to control brush or cheatgrass and seeding grasses are practical. Where a reasonably good stand of perennial grasses is under the brush, spraying alone is practical.

SCABLAND RANGE SITE

This range site is on Bakeoven soils. It is mainly in the eastern and southern parts of the survey area. These soils are well drained. They have a surface layer of very cobbly loam or very stony loam, and a subsoil of very cobbly loam or very cobbly clay loam. They formed in loess and in residuum weathered from basalt on uplands. They are nearly level to moderately steep.

Elevation ranges from 1,600 to 3,600 feet. The average annual precipitation is 10 to 13 inches. Runoff is slow to rapid, and the hazard of erosion is slight or moderate. Permeability is moderately slow, and the water-supplying capacity is less than 2.5 inches. Roots penetrate to a depth of 4 to 12 inches. The major forage grass, Sandberg bluegrass, begins to grow about April 1. Some areas commonly have a distinctive pattern of circular mounds, or biscuits, surrounded by scabland (fig. 8).

Where this site is in poor condition, the already sparse stand of bunchgrasses has been nearly eliminated. Sandberg bluegrass is depleted, and stiff sagebrush and forbs have increased. If deterioration is severe, only bare ground, stones, and hedged sagebrush occupy the site.

Special improvement measures generally are not suited to this site. Stiff sagebrush is a natural part of the plant community and provides valuable forage late in fall, in winter, and early in spring. Brush spraying should be avoided to protect the stiff sagebrush.

In areas of this range site in the southern part of the survey area south of Tygh Valley, western juniper has a canopy cover of 5 to 10 percent. These areas are in a 12- to 16-inch precipitation zone. The vegetation consists of Sandberg bluegrass, 45 percent; bluebunch wheatgrass, 2 percent; Thurber needlegrass, 2 percent; Oregon bluegrass, 5 percent; squirreltail, 2 percent; lomatium, 2 percent; snow eriogonum, 5 percent; western juniper, 35 percent; and other shrubs, 2 percent.

DROUGHTY SOUTH EXPOSURE RANGE SITE

This range site is on Anderly, Duart, Lickskillet, and Walla Walla soils. It is in the eastern part of the survey area. These soils are well drained silt loams and very stony loams that formed in loess, volcanic ash, and mixed colluvium. They are steep and very steep and have south-facing slopes. They are on uplands. Elevation ranges from 200 to 2,800 feet. The average annual precipitation is 10 to 14 inches. Runoff is rapid, and the hazard of erosion is severe. Permeability is moderate, and the water-supplying capacity is 2 to 12 inches. Roots penetrate to a depth of 12 to 60 inches or more. Major forage grasses begin to grow about March 1.

Where this site is in poor condition, the perennial bunchgrasses have been nearly eliminated. Squirreltail and a small amount of bluebunch wheatgrass are in some protected places, such as under the brush or in rocky areas. If deterioration is severe, big sagebrush,

Figure 8: Scabland range site is in foreground (biscuit part is Condon soil). The cultivated field in the center is Condon silt loam, 2 to 20 percent slopes. Scabland range site is in near background, and Rolling Hills range site is in far background.

snakeweed, and rabbitbrush become dominant and annual grasses and weeds invade the site.

Special improvement measures generally are suited to this site. If the range is in poor condition, spraying to control brush and seeding grasses are practical. However, drill seeding on the very stony Lickskillet soil is hard on equipment and is not considered practical. Where brush control is a concern and a reasonably good stand of grass is under the brush, spraying alone can be the most practical way of returning this site to optimum production.

DROUGHTY STEEP SOUTH RANGE SITE

This range site is on Lickskillet and Sherar soils. It is mainly on the breaks of the Deschutes River along the eastern boundary of the survey area. These soils are well drained extremely stony loams and very cobbly loams that formed in loess and colluvium. They are very steep and have south-facing slopes. They are on uplands (fig. 9). Elevation ranges from 200 to 300 feet. The average annual precipitation is 10 to 13 inches. Runoff is rapid, and the hazard of erosion is severe. Permeability is slow to moderate, and the water-supplying capacity is 2 to 5 inches. Roots penetrate to a depth of 12 to 40 inches. Major forage grasses begin to grow about February 20.

Where this site is in poor condition, broom snakeweed, rabbitbrush, and big sagebrush have nearly replaced the stand of forage bunchgrasses. Cheatgrass and low-value forbs are dominant. If deterioration is severe, much of the ground is bare and rocky.

Special improvement measures generally are not suited to this site because the soils are steep, extremely stony or very cobbly, and very droughty.

SOUTH EXPOSURE RANGE SITE

This range site is only on Bodell cobbly loam, 5 to 45 percent slopes. It is mainly in the northwestern part of the survey area. This soil is well drained. It formed in loess, volcanic ash, and basalt colluvium. It is nearly level to steep and has south-facing slopes. It is on uplands. Elevation commonly ranges from 500 to 2,500 feet. The average annual precipitation is 20 to 30 inches. Runoff is slow to rapid, and the hazard of erosion is slight to severe. Permeability is moderate, and the water-supplying capacity is 4 to 7 inches. Roots penetrate to a depth of 12 to 20 inches. Major forage grasses begin to grow about March 1.

Where this site is in poor condition, cheatgrass and a variety of forbs have nearly replaced the stand of perennial bunchgrasses. If deterioration is severe, annual forbs and low-value grasses dominate, and the site takes on a weedy appearance.

Special improvement measures generally are not suited to this site because the soil is stony and shallow.

Figure 9: Lickskillet extremely stony loam, 40 to 70 percent slopes, in Droughty Steep South range site.

STEEP SOUTH RANGE SITE

This range site is only on Bodell very cobbly loam, 45 to 75 percent slopes. It is mainly in the northwestern part of the survey area. This soil is well drained, and it formed in loess, volcanic ash and in basalt colluvium. It is very steep and has south-facing slopes. It is on uplands. Elevation commonly ranges from 500 to 2,500 feet. The average annual precipitation is 20 to 30 inches. Runoff is rapid, and the hazard of erosion is high. Permeability is moderate and the water-supplying capacity is 4 to 7 inches. Roots penetrate to a depth of 12 to 20 inches. Major forage grasses begin to grow about March 1.

Where this soil is in poor condition, cheatgrass and a variety of forbs have nearly replaced the stand of perennial bunchgrasses. If deterioration is severe, annual forbs and low-value grasses dominate and the site takes on a weedy appearance.

Special improvement measures are not suited to this site because it is steep, stony, and shallow.

DROUGHTY NORTH EXPOSURE RANGE SITE

This range site is on Cantala, Dufur, Sinamox, Walla Walla, and Wato soils. It is in the eastern part of the survey area. These soils are well drained silt loams and very fine sandy loams that formed in loess, volcanic ash, and alluvium. They have north-facing slopes and are on uplands.

Elevation ranges from 800 to 3,000 feet. The average annual precipitation is 10 to 14 inches. Runoff is medium or rapid, and the hazard of erosion is moderate or high. Permeability is moderate or moderately slow, and the water-supplying capacity is 6 to 12 inches. Roots penetrate to a depth of 40 to more than 60 inches. Major forage grasses begin to grow about March 1.

Where this site is in poor condition, the forage bunchgrasses are low in vigor and widely spaced. The mulch layer of lichens and mosses that protected the surface layer has been destroyed and bare ground is exposed. During deterioration, bluebunch wheatgrass, temporarily increases and dominates in places because selective summer grazing by cattle and heavy use by sheep or deer deplete the stand of Idaho fescue. If deterioration is severe, snakeweed, annual grasses, and brush are prominent.

Special improvement measures are suited to this site. If the range is in poor condition, spraying to control brush and seeding grasses are practical. Were a reasonably good stand of grass is under the brush spraying alone can be the most practical way of re turning the site to optimum production.

NORTH EXPOSURE RANGE SITE

This range site is on Cantala, Dufur, Walla Walla Watama, Wapinitia, and Wato soils. It is in the eastern part of the survey area. These soils are well drained silt loams and very fine sandy loams that former mainly in loess and volcanic ash. They are steep and have north-facing slopes. They are on uplands.

Elevation ranges from 1,000 to 3,600 feet. The average annual precipitation is 10 to 16 inches. Runoff is rapid, and the hazard of erosion is severe. Permeability is moderate or moderately slow, and the water-supplying capacity is 6 to 14 inches. Roots penetrate to a depth of 20 to 60 inches. Major forage grasses begin to grow about March 15.

Where this site is in poor condition, the forage bunchgrasses are low in vigor and widely spaced. The mulch layer of lichens and mosses that protected the surface layer is destroyed and bare ground is exposed. Sandberg bluegrass and perennial forbs are prominent in the stand. During deterioration, bluebunch wheatgrass temporarily increases and dominates in places because selective summer grazing by cattle and heavy use by sheep or deer deplete the stand of Idaho fescue. If deterioration is severe, the site becomes weedy and brushy.

Special improvement measures generally are suited to this site. If the range is in poor condition and a reasonable stand of grass is under the brush, spraying to control brush can be the most practical way of returning the site to optimum production.

STEEP NORTH RANGE SITE

This range site is on Nansene, Sinamox, and Wrentham soils. It is in the eastern part of the survey area. These soils are well drained silt loams that formed in loess and mixed colluvium. They are steep or very steep and have north-facing slopes. They are on uplands.

Elevation ranges from 300 to 3,600 feet. The average annual precipitation is 10 to 13 inches. Runoff is rapid, and the hazard of erosion is severe. Permeability is moderate, and the water-supplying capacity is 6 to 12 inches. Roots penetrate to a depth of 20 inches to more than 60 inches. Major forage grasses begin to grow about April 1.

Where this site is in poor condition, the forage bunchgrasses are low in vigor and widely spaced. The mulch layer of lichens and mosses that protected the surface layer has been destroyed and bareground is exposed. Sandberg bluegrass and perennial forbs are prominent. During deterioration, bluebunch wheatgrass temporarily increases and dominates the site in places because selective summer grazing by cattle and heavy use by sheep and deer deplete the stand of Idaho fescue. If deterioration is severe, sagebrush and cheatgrass invade strongly and the site becomes weedy and brushy.

Special improvement measures generally are not suited to this site because the soils are steep. However, if the range is in poor condition and a reasonable stand of grass is under the brush, spraying to control brush on the more gently sloping soils is practical.

SHRUBBY ROLLING HILLS RANGE SITE

This range site is on Maupin, Maupin variant, Sinamox, Watama, Wapinitia, and Wapinitia variant soils. It is in the southern part of the survey area south of Tygh Ridge. These soils are well drained loams and silt loams that formed in volcanic ash and in colluvium They are nearly level to moderately steep and are on uplands.

Elevation ranges from 1,500 to 3,400 feet. The aver-

age annual precipitation is 10 to 16 inches. Runoff is slow or medium, and the hazard of erosion is slight or moderate. Permeability is moderate or moderately slow, and the water-supplying capacity is 6 to 14 inches. Roots penetrate to a depth of 20 to 60 inches. Major forage grasses begin to grow about March 15.

Where this site is in poor condition, bluebunch wheatgrass and Idaho fescue have been nearly eliminated from the stand. Bitterbrush is commonly hedged, and dead plants occur. Low-value shrubs increase, and juniper from adjacent areas invade the site in places. If deterioration is severe, annual weeds invade the areas of shallow and eroded soils.

Special improvement measures are suited to this site. If the range is in poor condition, clearing the juniper or spraying to control brush and seeding grasses are practical. Where brush is the concern and a reasonably good stand of grass is under the brush, spraying alone can be the most practical way of returning this site to optimum production. Plans for manipulating brush should consider the amount and value of existing bitterbrush and other forage shrubs.

In the area south of Tygh Valley in the southern part of the survey area, Maupin and Watama soils in this range site are mapped in complexes with Bakeoven soils (see Scabland range site description). For the percentages of Maupin and Watama soils in these mapping units, see descriptions of the mapping units.

SHRUBBY SOUTH EXPOSURE RANGE SITE

This range site is on Sherar cobbly loam, 5 to 45 percent slopes. It is in the southern part of the survey area, south of Tygh Ridge. These soils are well drained cobbly loams that formed in loess and colluvium. They have south-facing slopes and are on uplands.

Elevation ranges from 1,500 to 2,500 feet. The average annual precipitation is 10 to 12 inches. Runoff is medium or rapid, and the hazard of erosion is moderate or severe. Permeability is slow, and the water-supplying capacity is 2 to 5 inches. Depth to very gravelly semiconsolidated tuff is 20 to 40 inches. Major forage grasses begin to grow about March 1.

Where this site is in poor condition, the forage bunchgrasses are low in vigor and widely spaced and matchweed, big sagebrush, and rabbitbrush are prominent. If deterioration is severe, the site becomes brushy and weedy. Bitterbrush and other forage shrubs are hedged, and dead plants occur.

Special improvement measures are suited to this site. If the range is in poor condition, reducing the brush and seeding grasses are practical. Where a reasonable stand of grass is under the brush, spraying for selective reduction of sagebrush and rabbitbrush can be the most practical way of returning the site to optimum production. Plans for manipulating brush should consider the amount and value of existing forage shrubs.

SILTY TERRACE RANGE SITE

This range site is on Warden silt loam, 5 to 40 percent slopes. It is commonly on terraces along the Deschutes River another places in the eastern part of the survey area. This well drained soil formed in loess and lacustrine silt. It is gently sloping on bench terraces and terrace fronts.

Elevation ranges from 600 to 1,000 feet. The average annual precipitation is 9 to 10 inches. Runoff is slow or medium, and the hazard of erosion is slight to severe. Permeability is moderate, and the water-supp1ying capacity is 6 to 9 inches. Roots penetrate to a depth of 40 to more than 60 inches. Major forage grasses begin to grow about March 1.

Where this site is in poor range condition, big sagebrush and gray rabbitbrush have nearly replaced the stand of bluebunch wheatgrass. If deterioration is severe, cheatgrass and annual weeds replace the perennial forbs and grasses.

Special improvement measures are well suited to this site. Where the range is in fair and poor condition, reducing brush and seeding drought-resistant grasses is practical. Where a reasonably good stand of perennial grasses remains under the brush, spraying alone may be the most practical way of returning this site to optimum condition.

SEMI-MOIST BOTTOM RANGE SITE

This range site is on Endersby, Hermiston, Quincy, and Tygh soils. These soils are well drained to somewhat poorly drained loams, silt loams, loamy fine sands, and fine sandy loams that formed mostly in alluvium. They are nearly level and are on bottom lands.

Elevation ranges from 200 to 2,500 feet. The average annual precipitation is 10 to 20 inches. Runoff is slow, and the hazard of erosion is slight. Some of the soils are subject to flooding and have a high water table, and the hazard of streambank erosion is high. Permeability is moderate or moderately rapid, and the water-supplying capacity is about 9 to 13 inches. Roots penetrate to a depth of 40 to more than 60 inches. Major forage grasses begin to grow about March 15.

Where this site is in poor condition, big sagebrush and rabbitbrush have nearly replaced the stand of giant wildrye. If deterioration is severe, the site becomes very brushy or very weedy and much ground is left bare.

Many areas of this site are in irrigated hay or pasture, but special improvement measures are suited to this site if it is not used for crops. Streamside vegetation, especially shrubs and giant wildrye, is important to streambank stabilization and wildlife cover, and it should be taken into account when planning management.

ALKALINE BOTTOM RANGE SITE

This range site is only on Pedigo silt loam. It is along drainageways in the eastern part of the survey area. This soil is somewhat poorly drained. It formed in alluvium from loess and some volcanic ash washed from uplands. It is nearly level and is on bottom lands.

Elevation ranges from 200 to 2,700 feet. The average annual precipitation is 10 to 13 inches. Runoff is slow, and the hazard of erosion is slight. However, during periods of high streamflow, the hazard of streambank erosion is severe in several places. Permeability is

moderate, and the water-supplying capacity is 9 to 13 inches. Roots penetrate to a depth of more than 60 inches. Major forage grasses begin to grow about April 1.

any areas of this site are in irrigated hay or pasture, but special improvement measures are well suited to this site if it is not used for crops. Streamside vegetation, especially giant wildrye and riparian shrubs, is important to streambank stabilization and wildlife cover, and it should be taken into account when planning management.

OAK SOUTH EXPOSURE RANGE SITE

This range site is on Cherryhill and Wamic soils. It is in the northwestern part of the survey area. These soils are well drained loams and silt loams that formed in loess, volcanic ash, colluvium, and alluvium. They are nearly level to very steep and have south-facing slopes. They are on uplands.

Elevation commonly ranges from 500 to 2,000 feet. The average annual precipitation is 14 to 20 inches. Runoff is medium or rapid, and the hazard of erosion is moderate to severe. Permeability is moderately slow, and the water-supplying capacity is 8 to 12 inches. Roots penetrate to a depth of 40 to more than 60 inches. Major forage grasses begin to grow about March 15.

Where this site is in poor condition, oaks and such perennial forbs as arrowleaf balsamroot and lupine have severely reduced the stand of forage bunchgrasses. If deterioration is severe, cheatgrass and other low-value plants dominate the understory.

Most areas of Cherryhill soils are in fruit orchards or other crops, but special improvement measures generally are suited to this site if it is not cultivated. Where the range has been burned, oak becomes more dense and reproduction is more profuse. After a fire, it is practical to broadcast seed of suitable plants before fall rains settle the seedbed. A major objective of seeding is to stabilize the soil and prevent excessive oak reproduction. The site provides important aesthetic values. Habitat for wildlife should be taken into account when planning management.

OAK STEEP SOUTH RANGE SITE

This ran e site is on Skyline and Hesslan soils. It is mainly in the no western part of the survey area. These soils are well drained stony loams and very cobbly loams that formed in loess, volcanic ash, and colluvium. They are nearly level to very steep and have south-facing slopes. They are on uplands.

Elevation commonly ranges from 1,000 to 3,500 feet. The average annual precipitation is 14 to 20 inches. Runoff is moderate or rapid, and the hazard of erosion is moderate or severe. Permeability is moderate. In the Skyline soils, roots penetrate to a depth of 12 to 20 inches and the water-supplying capacity is 6 to 9 inches. In the Hesslan soils, roots penetrate to a depth of 20 to 40 inches and the water-supplying capacity is 5 to 7 inches. Major forage grasses begin to grow about March 15.

Where this site is in poor condition, cheatgrass, annual weeds, and other shallow-rooted plants have replaced the stand of tall bunchgrasses. If deterioration is severe, much ground is left bare.

Special improvement measures are not suited to this site because the soils are steep and stony or cobbly.

OAK STEEP NORTH RANGE SITE

This range site is on Hesslan soils of the Skyline-Hesslan complex, 30 to 70 percent slopes. It is mainly in the northwestern part of the survey area. These are well drained stony loams that formed in loess, volcanic ash, and colluvium. They are steep or very steep and have north-facing slopes. They are on uplands.

Elevation commonly ranges from 1,000 to 3,000 feet. The average annual precipitation is 14 to 20 inches. Runoff is rapid, and the hazard of erosion is high. Permeability is moderate, and the water-supplying capacity is 6 to 7 inches. Roots penetrate to a depth of 20 to 40 inches or more. Major forage grasses begin to grow about April 1.

Where this site is in poor condition, oaks and such perennial forbs as lupine and arrowleaf balsamroot have severely reduced the stand of forage bunchgrasses. If deterioration is severe, cheatgrass and other plants of low-forage value dominate the understory.

Special improvement measures are not suited to this site because the soils are steep and stony. Where the range has burned, dense stands of oak occur. After fire it is practical to broadcast seed suitable plants before fall rains settle the seedbed. A major objective of seeding is to stabilize the soil and prevent excessive oak regeneration. This site also provides important forage and cover for deer and other wildlife, which needs to be taken into account when planning management.

OAK-PINE STEEP SOUTH RANGE SITE

This range site is on Bald very cobbly loam, 45 to 75 percent slopes. It is in the northwestern part of the survey area. This soil is well drained, and it formed in loess, volcanic ash, and basalt colluvium. It is very steep and has south-facing slopes. It is on uplands.

Elevation commonly ranges from 200 to 3,000 feet. The average annual precipitation is 25 to 30 inches. Runoff is rapid, and the hazard of erosion is high. Permeability is moderate, and the water-supplying capacity is 12 to 15 inches. Roots penetrate to a depth of 20 to 40 inches. Major forage grasses begin to grow about March 1.

Where this site is in poor condition, cheatgrass and other shallow-rooted plants occupy the openings. Also, perennial forbs, shrubs, and white oak reproduction have reduced, the stand of forage bunchgrasses. If deterioration is severe, much ground is left bare.

Special improvement measures are not suited to this site because this soil is very steep and very cobbly.

PINE•OAK•FESCUE RANGE SITE

This range site is on Chenoweth, Cherryhill, Van Horn, Wamic, and Wind River soils. Wamic soils are along the western part of the survey area, and they sometimes occur as small hummocks interspersed with areas of shallow and very stony scabland. The other

soils are in the northwestern part of the survey area. These soils are well drained loams, silt loams, and fine sandy loams that formed in loess, volcanic ash, and alluvium. They are on ridgetops and on uplands. They are nearly level to steep.

Elevation commonly ranges from 100 to 2,500 feet. The average annual precipitation is 14 to 30 inches. Runoff is slow to rapid, and the hazard of erosion is slight to severe. Permeability is moderately slow to moderately rapid, and the water-supplying capacity is 8 to 14 inches. Roots penetrate to a depth of 40 to more than 60 inches. Major forage grasses begin to grow about March 15.

Where this site is in poor condition, the competition from dense shrub and oak reproduction severely reduces the stand of understory plants, especially grasses. If deterioration is severe, cheatgrass and other low-value plants dominate and much soil is bare.

Many areas of the site are used for fruit orchards or other crops, but in uncultivated areas, special management is suited to this site to improve plant resources. Where the range has been cut over or burned, oak reproduction and shrub growth occur in a dense stand. After a fire, it is practical to broadcast seed suitable plants before fall rains settle the seedbed. A major objective of seeding is to stabilize the soil and prevent excessive oak and shrub reproduction. This site provides important aesthetic values, habitat for wildlife, and is a component of the deer and elk winter range in this area. These considerations need to be taken into account when planning management alternatives.

Shallow and very cobbly Skyline soils interspersed with the deeper Wamic soils are also in this site. They are in a complex pattern, and it was not practical to separate them. Only the Wamic soils should be considered when evaluating forage production for the site. For the percentage of each soil refer to the mapping unit description for Wamic-Skyline complex, 2 to 20 percent slopes.

PINE-DOUGLAS FIR-SEDGE RANGE SITE

This range site is on Bald, Cherryhill, Frailey, and Wamic soils. Bald and Cherryhill soils are in the northwestern part of the survey area. Frailey and Wamic soils are along the western part of the survey area. These soils are well drained silt loams, loams, and cobbly loams that formed in loess, volcanic ash, colluvium, and alluvium. Slopes are 5 to 70 percent. The soils are on uplands.

Elevation ranges from 500 to 3,000 feet. The average annual precipitation is 14 to 30 inches. Runoff is slow to rapid, and the hazard of erosion is slight to severe. Permeability is moderately slow or moderate, and the water-supplying capacity is 8 to 15 inches. Roots penetrate to a depth of 20 to 60 inches. Major forage grasses begin to grow about March 15 in most areas.

In the absence of fire and where ponderosa pine has been logged from the stand, the more shade-tolerant Douglas-fir has increased in abundance and dominates many of the present stands. As the understory deteriorates, elk sedge and other forage bunchgrasses lose vigor and decrease in the stand. If deterioration is severe, the more densely shaded areas have only a few spindly shrubs, scattered forbs, and an occasional spear of grass.

Where this site has been severely cut over or burned, shrubs of many kinds increase in vigor and abundance, and the range can produce a considerable amount of forage for a number of years. After fire or logging, it is practical to broadcast seed suitable plants in disturbed areas before fall rains settle the seedbed. A major objective of seeding is to stabilize the soil and prevent excessive shrub reproduction. This site provides important forage and cover for deer and elk, which need to be taken into account when planning management.

Woodland and Windbreaks

In this section, the relationship between soils and trees is described. Interpretations useful to landowners and operators in developing and carrying out plans for establishment and management of tree crops (fig. 10) and windbreaks are given.

Forests cover about 65,000 acres, or 12 percent of the survey area. About 35 percent is owned by farmers, 37 percent is privately owned, 23 percent is owned by the forest industry, and 5 percent is owned by Federal and local governments.

The principal forest cover types (9) include inland Douglas-fir, ponderosa pine, and western juniper.

Woodland management and productivity

Table 4 contains information useful to woodland owners or forest managers planning the use of soils for wood crops. Those soils suitable for wood crops are listed, and the woodland group for each soil is given. All soils in the same woodland group require the same general kinds of management and have about the same potential productivity.

The first part of the woodland group, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *f* indicates high content of coarse fragments in the soil profile, and *r,* steep slopes.. The letter *o* indicates no significant limitations or restrictions.

In table 4 the soils are also rated for a number of factors to be considered in management. The ratings slight, moderate, and severe are used to indicate the degree of major soil limitations.

The hazard of erosion indicates the risk of loss of soil in well-managed woodland. The risk is *slight* if the expected soil loss is small; *moderate* if some measures are needed to control erosion during logging and road construction; and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

JAMES T. BEENE, forester, Soil Conservation Service, helped prepare this section.

Figure 10: Thinning mixed pine and fir stand on Wamic loam, 12 to 20 percent slopes.

Equipment limitation ratings reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings when plant competition is not a limiting factor. The ratings are for seedlings from good planting stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than *25* percent; *moderate, 25* to *50* percent; and *severe,* more than *50* percent.

Plant competition ratings indicate the degree to which undesirable pants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The *potential productivity* of merchantable trees on a soil is expressed as *a site index.* This index is the average height, in feet, of the dominant and codominant Douglas-fir trees at the age of *50* years (4) and ponderosa pine at 100 years. The site index applies to fully stocked, even-aged, unmanaged stands. Conversion of site index into yield may be made by referring to table *5* and 6.

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Windbreaks

Windbreaks are established to protect livestock, buildings, and yards from winds and snow (13). Windbreaks also help protect fruit trees and gardens,

In the original manuscript, there was a table in this space.
All tables have been updated and are available as a separate document..

and they furnish habitat for wildlife. Several rows of both broadleaved and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind and hold snow on the fields, and they also provide food and cover for wildlife.

Some plants help to beautify and screen homes and other buildings and to abate noise around them. The plants, mostly evergreen shrubs and trees, are closely spaced. Healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can ensure a high degree of plant survival.

Windbreak groups

Most soils of the survey area have been placed in one of two windbreak groups. Timbered soils, steep soils, and shallow soils are excluded.

WINDBREAK GROUP 1

This group consists of well drained to poorly drained silt loams, loams, fine sandy loams, and loamy fine sands. These soils are on uplands, fans, and alluvial bottoms. Slopes are mainly 0 to 30 percent. The native vegetation is grasses, forbs, shrubs, and some oaks and ponderosa pine. The average annual precipitation is about 10 to 30 inches. Runoff is slow to rapid, and the hazard of erosion is slight to severe.

Successful dryland plantings require careful site preparation and clean cultivation. Irrigated windbreaks need to be cultivated in early years of establishment to the degree that competing vegetation does not seriously impede survival or growth of windbreak species.

The suited deciduous trees are black locust and Russian-olive. The suited shrubs are common lilac, caragana, Amur honeysuckle, and Tatarian honeysuckle. The suited evergreens are Rocky Mountain juniper, Austrian pine, Scotch pine, and ponderosa pine. Junipers are hosts to the cedar-apple rust disease and, consequently, should not be planted in areas of apple orchards.

Lombardy poplar, hybrid poplar, Douglas-fir, black willow, mountain ash, and Nanking cherry are suited where precipitation is more than about 15 inches or where the soils are irrigated.

WINDBREAK GROUP 2

This group consists of well drained silt loams, loams, and very fine sandy loams on uplands. Slopes are mainly 0 to 40 percent. The native vegetation is grasses and forbs. The average annual precipitation is about 9 to 16 inches. Runoff is slow or medium, and the hazard of erosion is slight or moderate. Most roots penetrate to a depth of 20 to 60 inches or more.

The soils in this group receive less precipitation than soils in group 1 and, consequently, windbreaks generally are more difficult to establish. Height, grow, and general development is slower. Planting sites need summer fallowing the year prior to planting, careful site preparation before planting, and clean cultivation throughout the life of the windbreak unless irrigated.

The suited deciduous trees are black locust and Russian-olive. The suited shrubs are common lilac and caragana. The suited evergreens are ponderosa pine and Rocky Mountain juniper.

Lombardy poplar, hybrid poplar, Douglas-fir, black willow, mountain ash, and Nanking cherry are also suited if irrigated.

Wildlife

All of the soils in the survey area are suited to and support habitat for one or more species of wildlife. This survey area embraces an area which includes the transition from arid grasslands to heavily timbered slopes on the side of Mt. Hood (fig. 11). Elevations range from 100 to 3,600 feet. The average annual

ROBERT A. CORTHELL, biologist, Soil Conservation Service, helped prepare this section.

Figure 11: Mule deer grazing in an open, grassy area. The soils are mostly Bakeoven, Condon, Lickskillet, and Wrentham soils.

precipitation ranges from 9 inches to more than 30 inches.

The transition from arid grassland to woodland has produced rich and varied plant communities which provide habitat for many kinds of wildlife. For example, oak and pine trees are common, and they are among the most valuable trees for wildlife. The distribution of wildlife has also been influenced by the proximity of the Columbia River Gorge which has allowed western Oregon species such as the black-tailed deer and the band-tailed pigeon to become established in the survey area on the east slope of the Cascade Mountain range. Species of wildlife that are not native to the area, such as ring-necked pheasant, chukar partridge, wild turkey, California quail, and Hungarian partridge, have been introduced and have found suitable habitat within the survey area.

Perennial streams which drain the survey area provide habitat for rainbow trout and steelhead trout. Fishpond construction has generally been limited by unfavorable soil characteristics, and fish production is only fair when ponds are constructed.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the development of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife either is scarce or does not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by properly managing the existing pant cover, and by fostering the natural establishment of desirable plants.

In table 7 the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in

1. Planning the use of parks, wildlife refuses, nature study areas, and other developments for wildlife.
2. Selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat.
3. Determining the intensity of management needed for each element of the habitat.
4. Determining areas that are suitable for acquisition to manage for wildlife.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention are required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and requires intensive effort. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils that have such a rating.

The elements of wildlife are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. Examples are wheat, oats, and barley. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and moisture are also considerations.

Grasses and legumes are domestic perennial grasses and herbaceous legumes used by wildlife for food and cover. Examples are fescue, bluegrass, bromegrass, timothy, orchardgrass, clover, alfalfa, and vetch. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and moisture are also considerations.

Wild herbaceous plants are native or naturally established herbaceous grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are balsamroot, goldenrod, beggarweed, big bluegrass, Sandberg bluegrass, wheatgrass, fescue, and milkvetch. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the sur-

face layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and moisture are also considerations.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Examples of native plants are Oregon white oak, cherry, apple, dogwood, sumac, blackberry, Oregon-grape, blueberry, and briers. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated good are Russian-olive and multiflora rose. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness.

Coniferous plants are cone-bearing trees, shrubs, or ground cover that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Examples are pine, spruce, hemlock, fir, and juniper. Major soil properties that affect the growth of coniferous plants are depth of the root zone, available water capacity, and wetness.

Shrubs are bushy woody plants that produce fruits, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Examples are mountainmahogany, bitterbrush, snowberry, and big sagebrush. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are wild millet, rushes, sedges, reeds, cordgrass, and cattail. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness.

Shallow water areas are bodies of surface water that have an average depth of less than 5 feet and are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife watering developments, beaver ponds, and other wildlife ponds. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadow, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include dove, quail, pheasant, meadowlark, field sparrow, killdeer, cottontail rabbit, and partridge.

Woodland habitat consists of hardwoods or conifers or a mixture of both, with associated grasses, legumes, and wild herbaceous plants. Examples of wildlife attracted to this habitat are wild turkey, ruffed grouse, blue grouse, mountain quail, band-tailed pigeon, tree squirrels, raccoon, deer, elk (fig. 12), and black bear. Tygh and Endersby soils are in the bottom land and Hesslan, Skyline, and Frailey soils occupy the steep slopes.

Wetland habitat consists of water-tolerant plants in open, marshy, or swampy shallow water areas. Examples of wildlife attracted to this habitat are ducks, geese, herons, kingfishers, muskrat, and beaver.

Rangeland habitat consists of wild herbaceous plants and shrubs on range. Examples of wildlife attracted to this habitat are deer, chukar, California and mountain quail, meadowlark, Hungarian partridge, and dove.

Recreation

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degrees, for recreational use by the duration of flooding and the season when it occurs. Onsite assessment of height, duration, and frequency of flooding is essential in planning recreational facilities.

In table 8 the limitations of soils are rated as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by additional information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 9, and interpretations for dwellings without basements and for local roads and streets, given in table 10.

Camp areas require such site preparation as shaping and leveling tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet nor subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

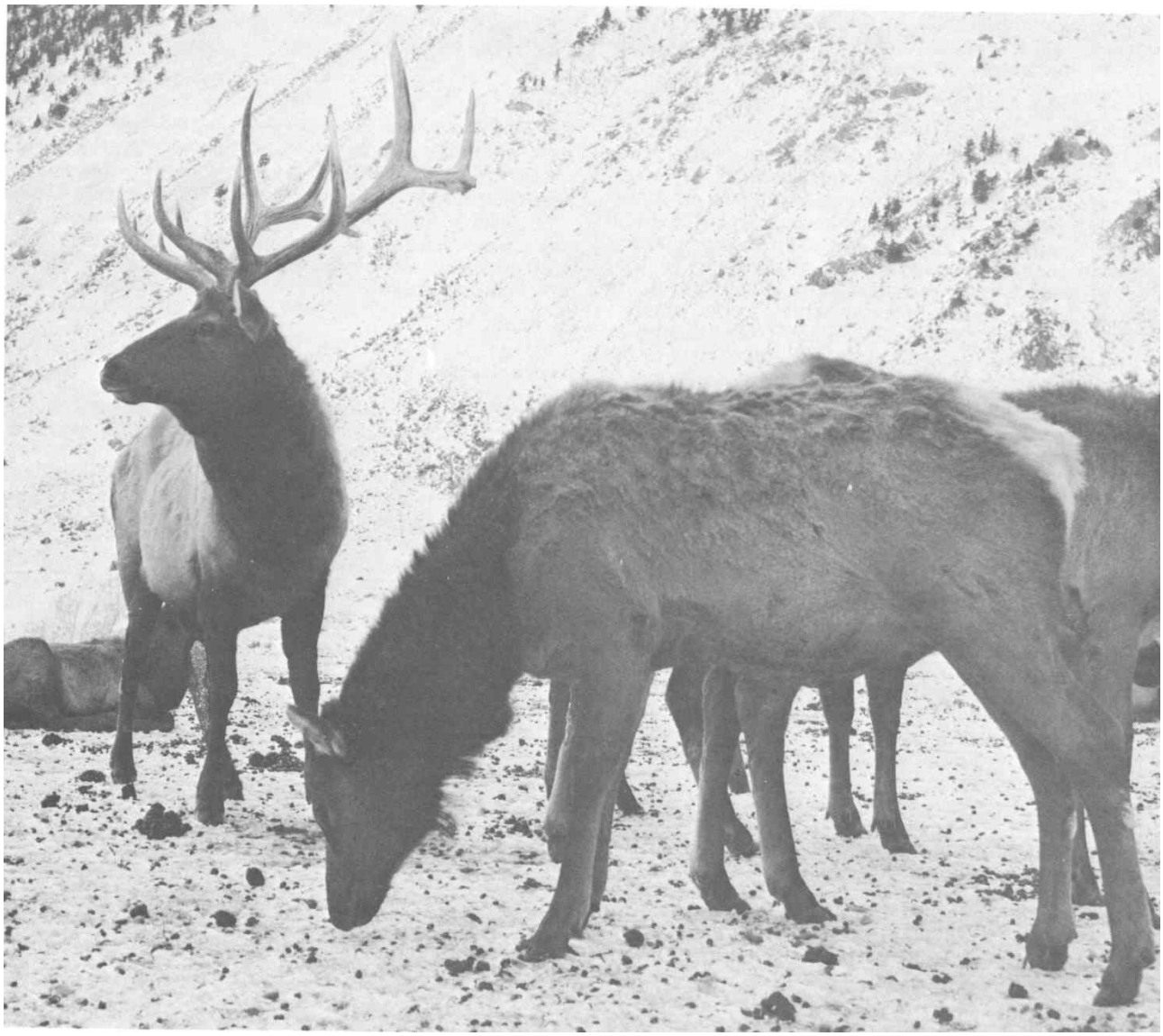

Figure 12: Elk wintering in woodland area.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and not wet nor subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rain, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over rock should be sufficient to allow necessary grading.

The design and layout of *paths and trails* for walking, horseback riding, and bicycling should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rain, are not dusty when dry, and are not subject to flooding more than once during the period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction materials, and water management. Among those who can benefit from this section are engineers, landowners, community decision makers and planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in tables in this section are based on test data and estimated data in the "Soil Properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by the soil survey and used in determining the ratings in this section are grain-size distribution, liquid limit, plasticity index, soil reaction, depth to and hardness of bedrock within 5 or 6 feet of the surface, soil wetness characteristics, depth to a seasonal water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cation were also considered.

Based on the information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to: select potential residential, commercial, industrial, and recreational areas; make preliminary estimates pertinent to construction in a particular area; evaluate alternate routes for roads, streets, highways, pipelines, and underground cables; evaluate alternate sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; plan detailed onsite investigations of soils and geology; find sources of gravel, sand, clay, and to soil; plan farm drainage systems, irrigation systems, pons, terraces, and other structures for soil and water conservation; relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations and testing.

The information is presented mainly in tables. Table 9 shows, for each kind of soil, ratings of the degree and kind of limitations for sanitary facilities; table 10 for building site development; and table 11, for water management. Table 12 shows the suitability of each kind of soil as a source of construction material.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have different meanings in soil science and in engineering; many of these terms are defined in the Glossary.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 9 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills.

If the degree of soil limitation is expressed as *slight,* soils are generally favorable for the specified use and limitations are minor and easily overcome; *if moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe, soil* properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance are required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect the absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, any susceptibility to flooding. Stones, boulders, and a shallow depth to bedrock interfere with installation. Excessive slope

ELWIN A. Ross, engineer, Soil Conservation Service, helped prepare this section.

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All tables have been updated and are available as a separate document.

may cause lateral seepage and surfacing of the effluent in downslope areas. Also, soil erosion and soil slippage are hazards where absorption fields are installed in sloping soils.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth of less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

Percolation tests are performed to determine the absorptive capacity of the soil and its suitability for septic tank absorption fields. These tests should be per-

formed during the season when the water table is highest and the soil is at minimum absorptive capacity.

On many of the soils that have moderate or severe limitations for septic tank absorption fields, a system to lower the seasonal water table or the size of the absorption field could be increased so that performance is satisfactory.

Sewage lagoons are sallow ponds constructed to hold sewage while bacteria decompose the solid and liquid wastes. Lagoons have a nearly level flow area surrounded by cut slopes or embankments of compacted, nearly impervious soil material. They generally are designed to hold sewage within a depth of 2 to 5 feet. Impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of local ground water. Soils that are very high in organic-matter content and those that have cobbles, stones, and boulders are undesirable. Unless the soil has very slow permeability, contamination of local ground water is a hazard in areas where the seasonally high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce its capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste, either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with thin layers or soil. Landfill areas are subject to heavy vehicular traffic. Ease of excavation, risk of polluting ground water, and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate or slow permeability, are deep to bedrock and a seasonal water table, are free of large stones and boulders, and are not subject to flooding. In areas where the seasonal water table is high, water seeps into the trenches and causes problems in excavating and filling the trenches. Seepage into the refuse increases the risk of pollution of ground water. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability that might allow noxious liquids to contaminate local ground water.

Unless otherwise stated, the ratings in table 9 apply only to soil properties and features within a depth of about 6 feet. If the trench is deeper, ratings of slight or moderate may not be valid. Site investigation is needed before a site is selected.

In the area type of sanitary landfill, refuse is placed on the surface of the soil in successive layers. The limitations caused by soil texture, depth to bedrock, and stone content do not apply to this type of landfill. Soil wetness, however, can be a limitation because of difficulty in operating equipment.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill during both wet and dry weather. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all horizons, the A horizon in most soils has the best workability, a higher content of organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluate are those that affect reclamation of the borrow areas, such as slope, erodibility, and potential for plant growth.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 10. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures are not feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by the soil wetness or seasonal high water table, the texture and consistence of soils, the tendency of soils to cave in or slough, and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is defined, and the presence of very firm or extremely firm horizons, generally difficult to excavate, is indicated.

Dwellings and small commercial buildings referred to in table 10 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gar-

dens. Depth to bedrock, slope, and the large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious limitation.

Local roads and streets referred to in table 10 have an all-weather surface that can carry light to medium traffic all year. They consist of subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load-supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic-supporting capacity used in making ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones, all of which affect stability and ease of excavation, were also considered.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 11 soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for this use have low seepage potential, which is determined by the permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and that has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability, texture, structure, depth to bedrock, hardpan, or other layers that influence rate of water movement, depth to the water table, slope, stability of ditchbanks, susceptibility to flooding, salinity and alkalinity, and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, Texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments, or a combination of channels and ridges, constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock; hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at nonerosive velocities. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Construction materials

The suitability of each soil as a source of road fill, sand, gravel, and topsoil is indicated in table 12 by ratings of good, fair, or poor. The texture thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluate to the depth observed and described as the survey is made, generally about 6 feet.

Roadfill is soil material used in embankments for roads. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil profile between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 13 provide more specific information about the nature of each horizon. This information can help determine its suitability for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as high shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 12 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of

the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 13.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plant life. Also considered is the damage that can result to the area from which the topsoil is taken.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent pant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated fair are loose sandy or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated poor are very sandy soils, very firm clayey soils, soils that have suitable layers less than 8 inches thick; soils that have large amounts of gravel, stones or soluble salts; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter. Consequently, careful preservation and use of material from these horizons is desirable.

Soil Properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness of the soil and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many of the soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classification, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

Engineering properties

Table 13 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area. These estimates are presented as ranges in values most likely to exist in areas where the soil is mapped.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Information is presented for each of these contrasting horizons. Depth to the upper and lower boundaries of each horizon in a typical profile of each soil is indicated. More information about the range in depth and about other properties of each horizon is given for each soil series in the section "Descriptions of the Soils."

Texture is described in table 13 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (2) and the American Association of State Highway and Transportation Officials Soil Classification System (AASHTO) (1). In table 13 soils in the survey area are classified according to both systems.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes - eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified as one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils.

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All tables have been updated and are available as a separate document.

Highly organic soils are classified as A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best sub grade material to 20 or higher for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 16. The estimated classification, without group index numbers, is given in table 13. Also in table 18 the percentage, by weight, of cobbles or the rock fragments more than 3 inches in diameter are estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

A comparison of these and other systems of size limits for soil separates can be found in the PCA soil primer (7).

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U. S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

All estimates in table 13 have been rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification of the marginal zone has been omitted.

Physical and chemical properties

Table 14 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the representative profile of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships between the soil characteristics observed in the field-particularly soil structure, porosity, and gradation or texture-that influence the downward movement of water in the soil. The estimates are for water movement in a vertical direction when the soil is saturated. Not considered in the estimates are lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in the planning and designing of drainage systems, in evaluating the poten-

tial of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted pants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25° C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 14. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A *high* shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion, as used in table 14, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the amounts of erosion that will result from specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in terms of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very *highly erodible,* but crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loamy, coarse sandy loamy, fine sandy loamy, and very fine sandy loamy. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loamy, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.
5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.
6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.
7. Silty clay loamy that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 15 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep to deep, moderately well drained to well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes is not considered flooding. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific food frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick in soils for a continuous period of more than 2 weeks during most years. The depth to a high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated are the depth to the high water table; the kind of water table, that is perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing wins to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at depths of 5 to 6 feet or less. For many soils, the limited depth to bedrock is apart of the definition of the soil series. The depths shown are based on measurements made in many soil borings and other observations during the soil mapping. The kind of bedrock and its relative hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth attachment on a 200 horsepower tractor, but hard bedrock generally requires blasting.

Cemented pans are hard subsurface layers that are strongly compacted indurated). Such pans cause difficulty in excavation. e hardness of pans is similar to that of bedrock.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing zone, which causes the formation of ice lenses. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not . artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Engineering test data

Samples from soils of the Dufur series representative of Wasco County, Northern Part, were tested by standard AASHTO procedures to help evaluate the soils for engineering purposes. Only selected layers of each soil were sampled. The results of these tests and the classification of each soil sample according to both the AASHTO and Unified systems are shown in table 16. The samples tested do not represent the entire range of soil characteristics in the survey area or even within the series sampled. The results of the tests, however, can be used as a general guide in estimating the physical properties of the soils. Tests made were for moisture-density relationships, grain-size distribution, liquid limit, and plasticity index.

In the moisture density, or compaction test, a sample of the soil material is compacted several times with 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 as moisture content increases. The highest density obtained in the compaction test is the maximum density. Moisture

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density data are important in construction because optimum stability is generally obtained if the soil is compacted to approximately 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, can be used to determine the relative proportions of the different size particles that make up the soil sample. The percentage of fine-grained material determined by the hydrometer method should not be used in determining textural classes of soils.

Liquid limit and plasticity index are discussed in the section relating "Engineering Properties."

The specific gravity of a soil is the ratio of the weight in air of a given volume of soil particles at a stated temperature to the weight in air of an equal volume of distilled water at stated temperature. Most soils have specific gravities in the range of 2.65 or 2.85.

Formation, Morphology, and Classification

In this section, the factors that have affected the formation and composition of the soils in the survey area are described, and some important morphological features are discussed. The last part of the section deals with the classification of the soils of the survey area.

Formation

Most soils are formed by weathering and other processes that act on parent material. The characteristics of the soil at any given point depend on the parent material, climate, plants and animas, relief, and time.

The active forces that gradually form a soil from parent material are climate and plant and animal life. Relief strongly influences natural drainage, aeration, runoff, erosion, and exposure to sun and wind, and, as a result, it influences the effectiveness of the active soil forming processes. Generally, soil forming factors are complex. Each force interacts with others and, slowly but constantly, changes are brought about. A soil passes slowly through stages that can be considered as youth, maturity, and old age. Therefore, the character and thickness of a soil depend upon the intensity of the soil forming processes, the length of time during which the various processes have acted, and the resistance of the parent material to change.

At any stage in formation, a soil can be affected by mechanical agencies and by man. The surface layer can be wholly or partly removed by erosion and the material beneath it can become exposed. The soil-forming forces then begin acting on the exposed material to form a new surface layer. Accelerated erosion caused by improper use can severely limit the use of the soil for many years. Grading, shaping, and leveling by man rearrange the soil horizons and interrupt the effects of soil forming factors. Irrigating a soil when it normally is dry has the effect of placing the soil in a different climate environment. Draining by ditch or tile drains counteracts the effects of relief and climate, thereby changing the relationship among the soil forming factors. Applying amendments and chemicals affects the chemical composition of the soil and the plant and animal life.

The soil forming factors are discussed in the paragraphs that follow.

Climate

The climate of the survey area is mainly semi-arid and most of the annual precipitation falls in winter. Climate affects the kind and amount of native vegetation. In parts of this survey area temperature in winter is so low that the soils are frozen for long periods. During these periods many soil-forming processes stop. The average annual air temperature is normally 45° to 52° F at low elevations and decreases to less than 45° at higher elevations within the survey area. The upper few inches of the soil is frozen for some period during winter, and daily freezing and thawing are common on south-facing slopes. Summer temperatures are cool.

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The total precipitation and season of distribution are such that most soils become thoroughly dry in some part of the solum for at least 60 days in most years. The average annual precipitation is 10 to 14 inches in the eastern part of the survey area and about 14 to 30 inches in the forested areas at higher elevations. Precipitation is mainly in the period between October and June. Summer precipitation is spotty and is mostly lost by evaporation. Rainfall is sufficient to only slightly leach or moderately leach the soils.

Living organisms

In well drained areas where the precipitation is 10 to 16 inches a year, the natural vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, Idaho fescue, big sagebrush, and bitterbrush. In these areas, the A horizon is about 10 inches thick and is more than 1 percent organic matter. As precipitation increases to more than 16 inches and elevation increases to more than 3,600 feet, conifer forests replace the grass and shrub vegetation.

Areas that are not well drained have native plants that differ from the types common in well drained areas. On the flood plains of streams, grasses, sedges, and rushes grow in various combinations. This vegetation supplies an abundance of organic matter, and soils in these areas commonly have an A horizon that is thicker than 10 inches.

Animals and insects that burrow in the soil influence soil formation but probably not as much as plants. Badger activity is common on sandy or loamy soils that are relatively free of stones.

Parent material

The soils of the survey area formed in residuum from the weathering of bedrock and in colluvium on sloping uplands and plateaus; material transported by water and deposited as unconsolidated deposits of clay, silt, and gravel; pumice and ash from volcanic activity; and loess that has been transported by wind from other areas. Soils formed in residuum and colluvium contain minerals and weathered products that have similar composition to the original rock. Alluvial and aeolian material has been mixed so that its original mineralogy is no longer distinct.

The size of particles, mineralogy, and thickness of the parent material have greatly influenced the nature of the soils. Some soil characteristics are inherited directly from the parent material. For example, the soils on uplands are generally shallow over bedrock and are stony. Soils that formed in material on alluvial fans and terraces generally are somewhat gravelly or cobbly and in places are high in content of pumice. Soils formed in loess are high in silt and are shallow to deep over bedrock.

Some of the oldest exposed geologic formations in the survey area are those of the Tertiary Period. (3). They are only minor in extent, and most of them have been covered by succeeding formations of the Quaternary Period consisting mostly of tuff and breccia beds. The material weathers readily resulting in soils that are high in content of clay. Sherar and Sinamox soils formed partly in residuum and colluvium weathered from breccia.

The Columbia River Basalt flow has preserved the major ridges adjacent to the Deschutes and Columbia Rivers. Tygh Ridge in the central part of the survey area is representative of the Columbia River Basalt. Bald, Bodell, Bindle, Bakeoven, and Lickskillet soils formed partly in residuum and colluvium weathered from this basalt. The basalt is commonly more than 1,000 feet thick.

The Dalles Formation has been deposited over older formations in the western part of the survey area (5). It was built up slowly, as is evidenced by buried soils in the regolith. Cherryhill, Duart, Frailey, Hesslan, Maupin, Skyline, Tygh, Wapinitia, and Watama soils formed partly in residuum and colluvium weathered from materials in this geologic formation.

During recent geologic times a mantle of loess was laid down over the entire survey area, but now it is thickest on north-facing slopes, mostly as a result of preferential erosion. It is a nonstratified and unconsolidated deposit by the wind. It is composed dominantly of silt-sized particles of feldspar, quartz, calcite, and

mica, ordinarily with accessory clay and sand. Typically, loess is very smooth and floury.

The loess probably originated from glacial outwash left in the channel of the Columbia River during the Ice Age, or Pleistocene Epoch. The loess probably accumulated chiefly in warm periods when the glaciers melted, the sedimentation of outwash was at a maximum, and the ground surface was neither frozen nor blanketed with snow. Winds from the northeast that blew across the bare outwash evidently started sand grains moving in a jumping motion. The jumping grains bombarded the surface and kicked silt particles into the air stream. The silt and very fine sand particles were carried toward the southwest and gradually settled throughout a wide area. In this area, there is a relationship between the texture and thickness of the loess. Closer to the source, the deposits are coarser textured and thicker. In a southerly direction farther from the source, the deposits are finer textured and thinner.

Along road cuts in the survey area, the loess stands in vertical banks as much as 10 feet thick. This phenomenon, peculiar to loess and common wherever loess occurs, results when the individual plate-shaped particles are laid down flat, much like the pages of a book. On slopes, however, because of the uniform size of the particles, loess is susceptible to water erosion if not protected by vegetation.

Loess contains a wide variety of easily weatherable minerals and together with other favorable qualities generally results in naturally fertile soils. Anderly, Cantala, Condon, Dufur, Hermiston, Nansene, Pedigo, Walla Walla, Warden, Wato, and Wrentham soils formed mostly in loess.

At one or more times during the deposition of the loess, volcanic ash also was deposited in the survey area. Most likely it came from the now extinct volcanoes of the Cascade Mountains. All of the soils in the survey area probably contain some volcanic ash, which consists of sharp edged, sand to silt sized particles of silica, feldspar, glass, and other materials. The Bins, Bindle, Ketchly, and Wamic soils formed in material high in volcanic ash.

Relief

Aspect, or the direction a slope faces, is one of the most important features of relief that has affected soil formation in this survey area. Soils that have south-facing slopes are warmer and drier than those that have north-facing slopes, have less natural vegetation and a lower content of organic matter, and have retained a thinner mantle of loess and volcanic ash against erosion.

Another important feature is slope gradient. Steep soils commonly have thinner and less distinct soil horizons than gently sloping soils, have a greater erosion hazard, and retain less water.

Most soils in the survey area are well drained. Wet soils are only on flood plains or in depressions on the upland plateaus.

Time

The length of time that soil parent material has been subjected to weathering in combination with other factors plays a significant role in soil formation. If other factors are equal, younger soils have less horizon differentiation than older soils. For example, Endersby and Hermiston soils formed in recent alluvium, and although leaching has been strong, no B horizon has formed. Lickskillet and Sherar soils formed under less precipitation but over a longer period of time and have a distinct B horizon.

Morphology

A soil is not easily studied in its natural position because only the surface is exposed. To see and study a soil, it is necessary to expose a vertical section, or profile. A profile generally consists of several layers, or horizons.

In the survey area, the differentiation of horizons is the result of one or more of the following: accumulation of organic matter in the A horizon, accumulation of silicate clay in the B horizon, retention of calcium, potassium, and magnesium to give high base saturation, accumulation or retention of calcium carbonate in lower horizons, and cementation by alkali soluble materials into a hardpan in well drained soils. Walla Walla soils, for example, reflect the accumulation of organic matters and retention of bases.

Organic matter has accumulated in the surface layer of all of the soils in the survey area to form an A horizon. The content of organic matter is lowest in Warden and Bakeoven soils and highest in Nansene and Wrentham soils. The removal of native vegetation from many soils and the subsequent reduction in organic matter under a summer-fallow system of farming have markedly changed the structure and water absorbing ability of the A horizon. Surface crusting, vesicular porosity, and massive or platy structure are common in the A horizon of soils that are cultivated.

Laboratory data on the content of clay confirms that the Cherryhill soils (table 17) have an argillic horizon. Ketchly, Sherar, Van Horn, and Wapinitia soils also have an argillic horizon, but no data are available on these soils. An argillic horizon results mainly from the translocation of silicate clay minerals and a greater formation of clay from primary minerals within the B horizon than within other horizons.

All of the soils in the survey area have moderate to high base saturation. Although data is not available for all soils, Warden soils probably have the highest base saturation and Bindle and Bins soils the lowest.

There is visible evidence of leaching of carbonates and salts in some soils in the survey area. Warden soils, which have been leached the least, have an accumulation of calcium carbonate below a depth of 21 inches. Bins and Bindle soils have been leached the most and generally contain no free carbonates.

Pedigo soils and wet spots in Hermiston soils have high sodium saturation. This probably has been caused by the sodium in the groundwater replacing other exchangeable cations.

Classification

Soils are classified so that we can more easily remember their significant characteristics. 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 management. 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.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils 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.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available (16).

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 differentiae used as a basis for classification are soil properties that can be observed in the field or that can be inferred either from other properties that are observable in the field, or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or factors that affect soil genesis. In table 17 soils of Wasco County, Northern Part, are placed in a family or higher taxonomic class of the current system. Categories of the current system are defined briefly in the following paragraphs.

ORDER. Ten soil orders are recognized. The differentiae for the orders are based on the kind and degree of the dominant soil forming processes that have gone on.

SUBORDER. Each order is subdivided into suborders that are based primarily on properties that influence soil genesis and that are important to plant growth, or that were selected to reflect what seemed to be the most important variables within the orders. The names of suborders have two syllables.

GREAT GROUP. Soil suborders are separated into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons, soil moisture and temperature regimes, and in base status.

SUBGROUPS. Great groups are subdivided into three kinds of subgroups: the central (typic) concept of the great groups (not necessarily the most extensive subgroup) ; the intergrades, or transitional forms to other orders, suborders, or great groups; and extragrade subgroups that have some properties that are representative of the great groups but that do not indicate transitions to any other known kind of soil.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks.

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SERIES. The series consists of a group of soils that are formed from a particular kind of parent material and have horizons that, except for texture of the surface soil, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Laboratory Data

Physical and chemical characteristics of some representative soils in Wasco County, Northern Part, are given in table 18. The procedures used in making the analyses are described in Soil Survey Investigations Report No. 1. (15).

In preparation for laboratory analyses, soil samples were collected from pits. After air drying, the samples

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were crushed and passed through a 2-millimeter, round hole screen. The fraction greater than 2 millimeters in diameter is reported as weighted percentage of the total sample. Analyses were made on soil material less than 2 millimeters in diameter. Results are reported on an ovendry basis.

The particle size distribution was determined by the pipette method. The amount of water and the bulk density at 1/3 bar tension were determined on plastic-coated clods in a porous-plate pressure cooker. Water held at 15-bar tension was measure on disturbed samples in a pressure membrane apparatus. Reaction is by glass electrode using soil-water ratios indicated. Organic carbon is by the Walkley-Black method. Total nitrogen is by the Kjeldahl method. Electrical conductivity is by method 3a, given in the U.S. Department of Agriculture Handbook "Diagnosis and Improvement of Saline and Alkali Soils" (12). The calcium carbonate equivalent was measured from the amount of carbon dioxide evolved on acidification of the sample. Extractable cations were leached with 1 N NH4OAc. Extractable sodium and potassium were determined by flame photometry; calcium by permanganate titration; and magnesium gravimetrically as pyrophosphate. Extractable acidity, or exchangeable hydrogen, was determined by the triethanolaminebarium chloride method. Cation-exchange capacity (CEC) is the sum of extractable cations and extractable acidity; base saturation is the sum of extractable calcium, magnesium, sodium, and potassium as percentage of the cation-exchange capacity.

The profile description for Chenoweth loam follows. The description for Cherryhill silt loam is on page 16, and for Walla Walla silt loam on page 32.

Chenoweth loam (S67-Ore-33-1 to 10) Wasco County, center of section 10, T. 1 N., R. 13 E.:

Ap1-0 to 6 inches; very dark brown (10YR 2/2) very fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many roots and pores; abrupt smooth boundary.

Ap2-6 to 10 inches; very dark brown (10YR 2/2) very fine sandy loam, grayish brown (10YR 5/2) dry; weak medium platy structure parting to weak fine granular; slight(hard, friable, slightly sticky, slightly plastic; many roots and tine pores; clear smooth boundary.

A3-10 to 17 inches; grayish brown (10YR 5/2) loam;

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weak fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many roots and fine pores; few noncalcareous nodules as much as 1 inch in diameter, but mainly 1/2 inch in diameter; many earthworm casts; thin patchy clay films on peds and on pores; gradual smooth boundary.

B21-17 to 25 inches; dark brown (10YR 3/3) loam or light very fine sandy clay loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to weak medium subangular blocky; very friable or friable, sticky, plastic; many roots and fine pores; very few thin clay films on peds and in pores; few earthworm casts; few noncalcareous nodules as much as I inch in diameter, but mainly about 1/2 inch in diameter; clay films nearly continuous on nodules; gradual wavy boundary.

B22-25 to 42 inches; dark brown (10YR 3/3) loam or light very fine sandy clay loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, sticky, plastic; many roots and fine pores; few thin clay films on peds and in pores; many noncalcareous very dark grayish brown nodules mainly about era inch in diameter; clear smooth boundary.

B3-42 to 50 inches; dark yellowish brown (10YR 3/4 and 4 / 4) loam or very fine sandy loam, brown (10YR 5/3) dry; massive and weak fine subangular blocky structure; soft, very friable, slightly sticky, slightly plastic; few nodules; many roots and fine pores; abrupt smooth boundary.

C1-50 to 70 inches; dark yellowish brown (10YR 3/4) very fine sandy loam, light yellowish brown (10YR 6/4) dry; massive; soft, friable, very slightly sticky, very slightly plastic; some fine roots and fine pores; gradual wavy boundary.

C2-70 to 82 inches; dark yellowish brown (10YR 3/4) very fine sandy loam, pale brown (10YR 6/3) dry; massive; soft, friable, slightly sticky, slightly plastic; few fine roots and fine pores; abrupt wavy boundary.

General Nature o f the Area

This section provides general information about the physiography, climate, history, transportation, and water supply of Wasco County, Northern Part. Census figures were not used from the U.S. Census of Agriculture for this area because the survey area covers only a part of the county.

Physiography

The survey area is partly on the Columbia Plateau physiographic province and partly on the Eastern Cas-

cade Mountain provinces. The Columbia Plateau is a lava-floored plain that has been uplifted since molten basalt flooded the area. That part of the Eastern Cascade province in the survey area is a high upland terrace of coarse alluvial and pyroclastic materials. This terrace is eroded, and wide nearly level ridgetops are between deep V-shaped canyons. Elevation ranges from 1,000 feet along the northern boundary to about 3,500 feet in the southwestern and western parts of the survey area. The Columbia River, which marks the northern boundary, has an average elevation of 97 feet. Escarpments and very steep slopes border the Columbia River and rise abruptly to the upland terraces.

Tygh Ridge, which is at an elevation of 3,150 feet, is 22 miles south of the Columbia River. North of this ridge, drainage is to the Columbia River. South of the ridge, drainage is to White River and then to the Deschutes River, which forms the eastern boundary of the survey area.

The Columbia River Watershed within the survey area, excluding drainage of the Deschutes River, covers about 338,629 acres. In some places narrow sandy terraces parallel the river; in others, vertical basalt escarpments rise from 800 to 1,000 feet. Except for a few acres of Riverwash, there are no large recent alluvial areas. Tributary streams, flowing directly to the river, have rather steep gradients and flow through deep, V-shaped canyons. Rock Creek, Mosier, Rowena, Mill, Three Mile, Five Mile, and Fifteen Mile Creeks terminate at the Columbia River.

The Juniper Flat and Wamic area, which is at an elevation of 1,600 to 3,400 feet, is south of Tygh Ridge. This upland plateau, which forms the southern boundary of the survey area, drains to the Deschutes River.

The Deschutes River and its main stem and tributaries have a watershed of 221,101 acres within the survey area. White River, south of Tygh Ridge, is one of its main perennial tributaries. Wapinitia and Nena Creeks terminate at the Deschutes River.

The elevation of the towns are The Dalles, 98 feet; Dufur, 1,319 feet; Friend, 2,450 feet; Mosier, 100 feet; and Maupin, 902 feet.

Patterned Ground, or "Biscuit Scabland" (14)

Patterned ground is the general term applied to biscuits or mounds, stone nets, and stone stripes that form distinct patterns on the ground surface (fig. 13). Patterned ground, locally called biscuit scabland, makes up about 35,000 acres. Theories of the origin of such landforms are numerous, and only one simplified explanation is given here.

A common kind of pattern that occurs under glacial influence, mainly in perennially frozen areas, indicates that frozen ground cracks at low temperatures and forms rectangular or polygonal patterns. Ice that forms in these nearly vertical cracks can develop into ice wedges. Commonly, these polygonal structures are the result of the contraction of a layer of homogeneous material, either soil or rock, that is perpendicular to the cooling surface. This is illustrated in the columnar

Figure 13: Area of biscuit scabland. The mounds, or biscuits, are Condon soils; surrounding the mounds is the very shallow Bakeoven soil.

jointing of basalt and in the formation of mud cracks.

The chief climatic significance of the soil patterns as landforms in the survey area is that frozen ground apparently existed in front of the continental glacier during glacial invasion. A regular pattern of polygonal fractures could form in ground frozen to a uniform dept as a result of contraction during periods of subfreezing temperature. Ice wedges could form in these if the temperature fluctuated but generally remained below freezing (6) . Then as the climate became warmer and the front of the continental glacier retreated northward, the ice wedges began to melt. The runoff waters could have caused the erosion and modification of the polygons or mounds.

The biscuits are round or elongated, erosion-modified, polygonal mounds that are underlain by basalt at a depth of 2 to 3 feet. The soil in these mounds has a more weakly defined profile than adjacent soils, but otherwise it is similar to Condon soils. Frost heaving probably was the cause of mixing of various sized fragments of basalt in the soil and of mixing of genetically formed horizons. The soil in the mounds is lighter colored than the adjacent soils and is somewhat more rapidly drained. The removal of large amounts of mineral soil in the formation of the mounds is obvious from the scabland that surrounds the mounds.

The soils in the scabland formed mainly in remnants of material not removed during the thawing of the ice wedges and in material more recently washed from the mounds.

A less striking feature than the mounds are the stone nets, which in places encircle the mounds, and the stone polygons on the scabland. These stone nets and polygons consist of various sized fragments of basalt as much as 2 feet in diameter. Studies of similar features elsewhere suggest that these may have resulted from frost heaving along the original ice-wedged cracks (8).

Where slope is steep, the stone nets and polygons form sorted stripes, or rows, of rock that vary in length and width. The mounds occupy the gentle upper slopes of many of the minor ridges; the sorted stone polygons, the moderately steep intermediate slopes; and the sorted stripes, the steepest slopes on the lower part of the ridges. In places there are sorted stripes that are not associated with nets, polygons, or mounds (6).

History

Wasco County, once the largest county in the United States, has been reduced to a fraction of its original size. At inception Wasco County encompassed about 130,000 square miles. It extended from the Cascade Mountains and from the Washington, Idaho, and Montana borders to the California, Nevada, and Utah borders. It now is in north-central Oregon between Hood River, Jefferson, and Sherman Counties, and the Columbia River. The county seat is The Dalles.

Wasco County was formed January 11, 1854, and maintained its original size until February 14, 1859,

By JOHN LUNDELL.

when Oregon gained statehood. Wasco County's eastern border was the Oregon-Idaho state line. Seventeen counties have been formed in Eastern Oregon out of old Wasco County. Baker County was the first in 1862, and Deschutes County petitioned away in 1916.

Indians living along the Columbia River were the first known inhabitants of the survey area, and fishing was their main livelihood. Indians from other tribes in the Pacific Northwest traveled annually to Winquatt (the Indian name for the geographical area now known as Petersburg, Thompsons Addition, the Dalles, and Chenoweth) to trade and barter for fish. The United States Government established the Warm Springs Indian Reservation in 1855, located partly in the southern part of Wasco County.

The Lewis and Clark Expedition came into the survey area on October 25, 1805. Their group camped at what they termed "Fort Rock," which is located near where Mill Creek enters the Columbia River. For about the next 25 years, the travelers in the area were interested in or associated with the fur trading industry. In 1820 the Hudson Bay Company established a temporary trading post at The Dalles. The region was explored by Peter Skene Ogden, Nathaniel Wyeth, and John C. Fremont.

From 1843 to 1848, wagon trains began arriving from the East over the Old Oregon Trail. At The Dalles they had two methods of reaching the Willamette Valley. One was to raft, boat, or float down the Columbia River. The other was to travel overland around Mt. Hood. A toll road was built around the south side of Mt. Hood in 1846. It began near Wamic in the central part of Wasco County. To get to the toll road some immigrant trains chose to leave the Columbia River just west of where the Deschutes River terminates and travel over the rolling hills to Fairbanks on Fifteen Mile Creek. They would then follow the creek up to Fifteen Mile Crossing (Dufur), over Tygh Ridge and down into Tygh Valley, and then up onto Wapinitia Flat to Wamic.

The Whitman Massacre occurred in 1847, and Oregon Territorial Governor Abernathy promptly dispatched a company of troops to The Dalles on December 8, 1847. Thus began what has to be considered the permanent establishment of a community in Wasco County. Dalles City was incorporated June 22, 1857. The military used the remains of the Methodist Mission buildings as quarters. The military maintained their post at Fort Dalles until the end of the Yakima Indian War in 1858 and then finally abandoned it in 1867.

Settlers started to locate in the rural areas of Wasco County along the numerous streams that flowed north and east from the Mt. Hood drainage system.

Discovery of gold in the early 1860's in the eastern and central parts of Oregon further hastened the settlement of Wasco County. Laborers were imported to help with the tedious digging task. Wagon stops were located out of The Dalles at half-day travel intervals. The main travel route went south across Three, Five, Eight, and Fifteen Mile Creeks, up over Tygh Ridge, and down into the Deschutes Canyon at Sherars Bridge. Crossing at the Deschutes River was a pleasant respite

from the hot, dry, dusty trail. On the trail out of the canyon were Bakeoven, Shaniko, and Antelope. So much gold was coming out of the John Day-Canyon City Country that the U.S. Government started construction of a mint at The Dalles. However, the precious metal source dwindled before coins could be minted.

Major transportation along the Columbia River in the Pioneer Period was confined to steamboats. The sternwheelers paddled up and down the river in front of The Dalles from the 1850's to about 1915. Scows were used to transport lumber from sawmills down the Columbia River, such as the one at Mosier, up to The Dalles. Completion of The Dalles-Celilo Canal in 1915 greatly increased water traffic to the Inland Empire Region.

The Dalles-Celilo Portage Railroad started in 1863. In 1882 The Dalles was connected to Portland by rail and to Wallula in 1883. The first branch railroad to the southern part of Wasco County was started in 1898, and it extended from Biggs in Sherman County to Shaniko. In 1905 John Heimrich built the Great Southern Railroad to Dufur and extended it into Friend in 1913. The Great Southern Railroad opened up the small communities and whistlestops of Petersburg, Fairbanks, Fulton, Brookhouse, Freebridge, Neabeck, Emerson, Wrentham, Rice, Boyd, Dufur, and Friend to regular rail travel. In 1909 the Union Pacific Railroad and the Spokane, Portland & Seattle fought their way to Central Oregon up the Deschutes River. Maupin became an important part of Wasco County's economy because most goods on the Wapinitia Flat are funneled through Maupin to the Oregon Trunk Railroad.

Automobiles and modern highways have aided residents in getting to and from the market places. The routes used are virtually the same. Only the mode and speed has changed.

Farming became big business in Wasco County in the 1860's. Sheep and cattle raised in the central and southern parts of the county contributed to the stability of the economy. Shaniko was once one of the world's largest wool shipping points. Wool buyers from all over the world came to The Dalles and used the famed Umatilla House as their headquarters. Wheat and other grains gradually gained acreage in the eastern and northern parts of the county. Irrigation made possible several cuttings of alfalfa each year, which are either used by the grower or sold to users in the Pacific Northwest. The fruit industry of cherries, peaches, apricots, and apples find world markets. Large apple orchards at Dufur and Ortley failed miserably.

Attempts to diversify the economy of Wasco County have been initiated primarily by the construction of The Dalles Dam. Until the 1950's the economy was virtually stagnant. A major aluminum plant using electrical power was the first attempt at change. The economy is farm oriented, and goods and services concentrate on that segment of the economy.

Climate

The survey area has very light annual total precipitation and somewhat extreme temperatures in both summer and winter. Records used in evaluating the temperature and precipitation were from Friend and Dufur for the Columbia Plateau area and from The Dalles located at the eastern end of the Columbia Gorge on the Columbia River flood plain.

By GILBERT L. STERNES, climatologist for Oregon, National Weather Service, U.S. Department of Commerce.

Temperature

Marine air moving up through the Columbia Gorge and spreading into the inland Columbia Basin has a significant moderating effect on the more extreme temperatures of both summer and winter. The occasional low winter temperatures are the result of strong invasions of very cold continental air from the northeast. Excessively warm temperatures are similarly the result of occasional high pressure during the summer stagnating either over the inland Columbia or Great Basins.

Temperatures have ranged from -30° to 115° F above, both recorded at The Dalles. In most years temperature is not more than 107° or lower than -3° (table 19).

The dates of low temperatures in spring or before which they will occur in fall are given in table 20. These temperatures are significant to various crops. The number of days between the average spring and fall dates of 32° temperature is often referred to as the growing season (table 21).

Precipitation

The average annual precipitation ranges from nearly 10 inches on the eastern edge of the survey area to about 30 inches on the higher slopes of the western part. Between 70 and 80 percent of the annual precipitation occurs in November to March. Only 5 to 10 percent occurs in June to August. The rest is fairly evenly divided between April and May and September and October. While most of the precipitation is in the form of rain, there is substantial snowfall almost every winter, particularly in the higher reaches of the western part of the survey area. The greatest 3-day total ever recorded in Oregon, other than in high mountain areas, was 54 inches at The Dalles. Measurable precipitation can be expected on about 75 days a year.

In table 22 is a summary of certain monthly and annual precipitation data.

Sunshine and cloudiness

There are about 100 to 120 clear, 80 to 90 partly cloudy, and 165 to 185 cloudy days a year. Actual sunshine records have never been made in the survey area, but in a study in which records of cloudiness in the area and of sunshine at surrounding points were analyzed, it is estimated that the sun shines about 20 to 30 percent of the time in December and January; 55 to 65 percent in April, May, and June; 75 to 85 percent in July, Au t, and early in September. Then it gradually decreases to t e winter average.

Relative humidity

In the early morning hours when the air temperature is the lowest, relative humidity of 90 to 100 percent occurs in the summer and is quite frequent almost

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any time of the day late in fall and in winter. In contrast, during the warmest part of the day in summer, it is not unusual to have a relative humidity of 10 to 20 percent. Occasionally it is even lower, although the average is 35 percent.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity. The capacity of soils to hold water available for use by most pants. 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. In this survey, the range in inches of water is given for each series. This amount is based on the minimum and maximum depths of profiles (to a maximum of 60 inches) and takes into account the different amounts of water held in the ranges of texture given for the profile.

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

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.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxides are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are-

Loose.-Noncoherent when dry or moist; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.-When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented.-Hard; little affected by moistening.

Crop year. The year in which a crop is harvested. It contrasts with the fallow year, the year in which no crop is grown and the soil accumulates moisture from the crop year.

Cross-slope farming. Plowing, cultivating, planting, and harvesting across the general slope, but not on the contour.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Diagnostic horizon. A combination of specific soil characteristics that indicate certain classes of soils. Those at the surface are called epipedons; those below the surface, diagnostic subsurface horizons.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.-Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.-Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.-Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.-Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are effected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained: Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided, Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.-Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.-Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Dryfarming. Producing crops that require some tillage in a subhumid or semiarid region, without irrigation. Dryfarming usually involves using periods of fallow during which enough moisture accumulates in the soil to allow production of a cultivated crop.

Duripan. A subsurface silica-cemented horizon.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated throw wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Favorable. Favorable soil features for the specified use.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

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Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gravel. Rounded or angular fragments of rocks up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Horizon,. soil. A layer of soil, approximately parallel to the Surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows

0 horizon.-An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.- The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.-A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

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 a combination op these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon: The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Illuviation. The accumulation of material in a soil horizon through the deposition of suspended material and organic matter removed from horizons above. Since part of the fine clay in the B horizon (or subsoil) of many soils has moved into the B horizon from the A horizon above, the B horizon is called an illuvial horizon.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance-few, common, and many; size-fine, medium, and coarse; and contrast-faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three single variables-hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.2 inch), moderately slow (0.2 to 0.6 inch, moderate (0.6 to 2.0) inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

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Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in H values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as

	pH		*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

Rooting depth. Shallow root zone. The soil is shallow over 4 layer that greatly restricts roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff ; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeter in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay, and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope, soil. Amount of deviation of a surface from the horizontal, usually expressed in percent. A 5-foot fall or rise per 100 feet of horizontal distance is a slope of 5 percent. The slope classes used in this survey are: 0 to 7 percent, nearly level or gently sloping; 7 to 12 percent, moderately sloping; 12 to 20 percent, moderately steep; 20 to 45 percent, steep; and 45 to 70 percent, very steep

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil depth. The depth to which ant roots penetrate; the depth to the underlying bedrock, hardpan, or other restrictive layer. The depth classes used in this survey area are: 4 to 20 inches, shallow; 20 to 40 inches, moderately deep; more than 40 inches deep.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are-platy (laminated), prismatic (vertical axis of aggregates longer than horizonal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water-supplying capacity. Water stored in the soil at the beginning of plant growth in the spring, plus rainfall not in excess of evapotranspiration during the growing season, less runoff.

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