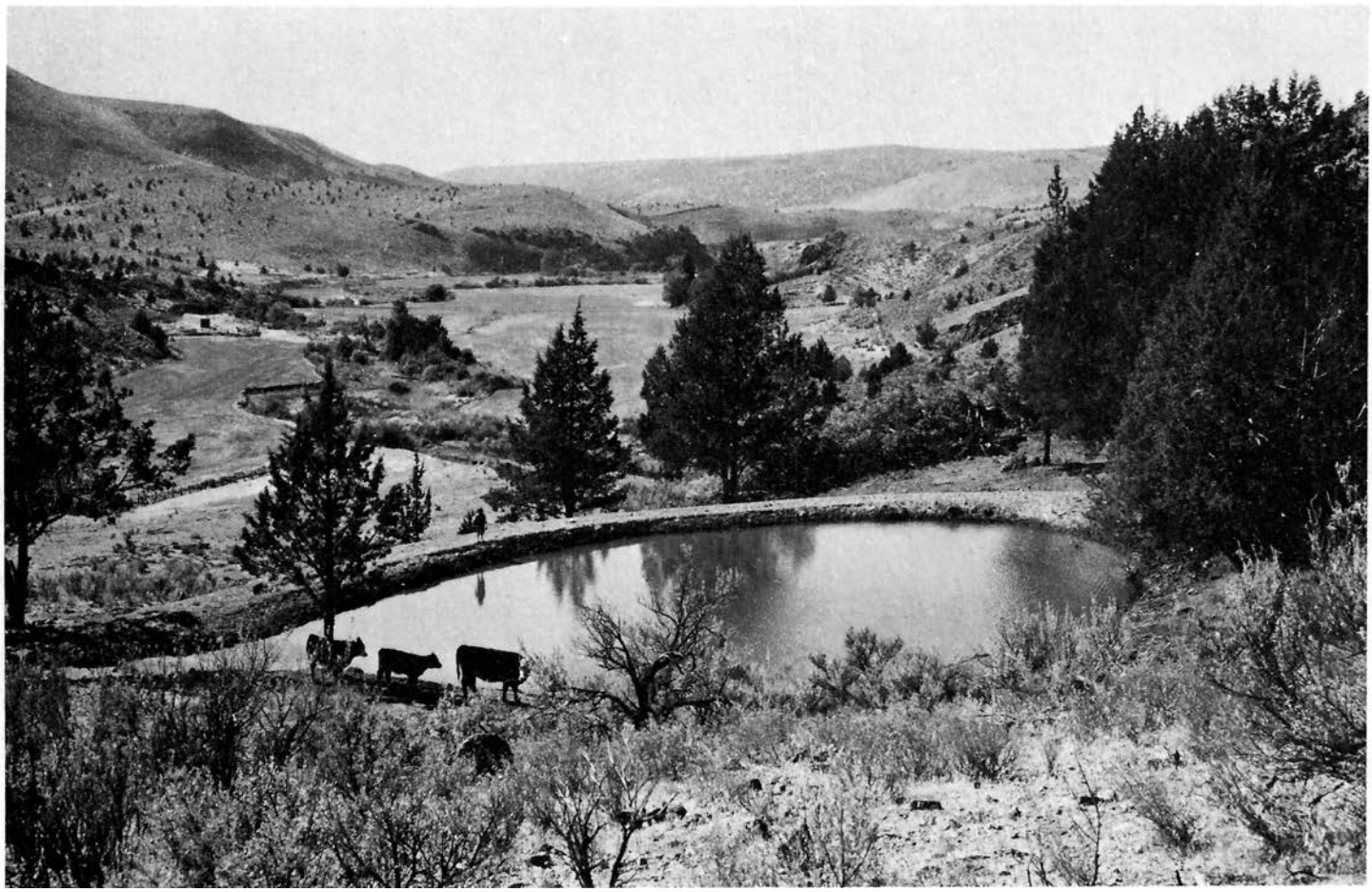
SOIL SURVEY OF

Trout Creek-Shaniko Area, Oregon

(Parts of Jefferson, Wasco, and Crook Counties)



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

Major fieldwork for this soil survey was done in the period 1959–69. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1970. This survey was made cooperatively by the Soil Conservation Service and Forest Service and the Oregon Agricultural Experiment Station. It is part of the technical assistance furnished to the Southern Wasco and the Trout Creek Soil and Water Conservation Districts.

Copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

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

Individual colored maps that show the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units, range sites, woodland suitability groups, and wildlife groups.

Foresters and others can refer to the section "Woodland," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife and Fish."

Ranchers and others can find, under "Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

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

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

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

Cover: **Stock pond on a Simas cobbly silty clay loam. Simas soils have low permeability when compacted, have good resistance to piping, and are in areas where springs are common. Cultivated fields in center are on Rail clay and Willowdale loam. In background are hilly Simas soils.**

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SOIL SURVEY OF TROUT CREEK-SHANIKO AREA, OREGON

(Parts of Jefferson, Wasco, and Crook Counties)

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

THE TROUT CREEK-SHANIKO AREA is east of the Cascade Mountains in the central part of Oregon (fig. 1). It occupies 938,960 acres, or 1,467 square miles. The survey area includes parts of Wasco, Jefferson, and Crook Counties. Madras, the Jefferson County seat, is west of the survey area and is the major business and transportation center.

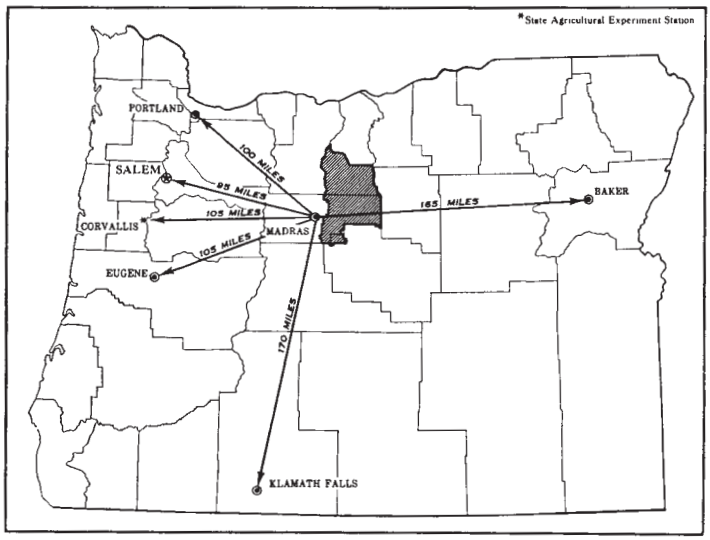

Figure 1.—Location of Trout Creek-Shaniko Area in Oregon.

The survey area is used mainly for farming. Raising beef livestock is the principal source of farm income. Grain is the main cash crop.

The survey area has great potential for the production of forage. Grasses growing on well-managed pasture have been producing forage for 25 years without loss of plant density or vigor. About 32,000 acres of the Crooked River National Grasslands, whose resources are managed by the Forest Service, is within the survey area.

Commercial recreation so far has been limited mainly to rock hounding and some fee hunting. Development of water-storage facilities and provision for game feed and protection should improve the wild game habitat.

Protection of the watershed through proper management, particularly on Trout and Willow Creeks, could reduce losses from soil erosion, stabilize water supplies, and increase suitability for crops on present bottom lands and some nonirrigated terraces.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the Trout Creek-Shaniko Area, 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 series* and the *soil phase* are the categories of soil classification most used in a local survey.

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

Soils of one series can differ in texture of the surface 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 manage-

ment. For example, Simas cobbly silty clay loam is one of several phases within the Simas 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.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some 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 the Trout Creek-Shaniko Area: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that 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 in the Trout Creek-Shaniko Area.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map can be made up of only one of the dominant soils or of two or more. Curant and Tub silt loams, 40 to 70 percent slopes, is an undifferentiated soil group in this survey area.

In most areas surveyed there are places where the soil material is so rocky, 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 land types and are given descriptive names. Riverwash is a land type in this survey area.

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 structure, foundations for structures, or 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 a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named 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 the Trout Creek-Shaniko Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association can 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 a survey area, who want to compare different parts of a survey 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 the Trout Creek-Shaniko Area are discussed in the following pages. For more detailed information about the individual soils in each association, refer to the detailed map and to the section "Descriptions of the Soils." Colors are for dry soils unless otherwise noted.

1. Hankins-Boardtree association

Deep cobbly loams and gravelly loams

This association consists of smooth, rolling soils on ridgetops and moderately steep to very steep soils on the sides of canyons. These soils formed in colluvium and ashy material over clayey sediment. The vegetation is Douglas-fir, ponderosa pine, shrubs, sedges, and grasses. Elevation ranges from 3,500 to 5,000 feet. Average annual precipitation ranges from 16 to 25 inches, and average annual air temperature ranges from 40° to 45° F. The frost-free period is 10 to 60 days at 32° and 80 to 110 days at 28°.

This association makes up about 6 percent of the survey area. It is about 60 percent Hankins soils, 30 percent Boardtree soils, and 8 percent Yawkey soils. Prag and Ginser soils, Rock outcrop-Rubble land complex, and Riverwash make up about 2 percent.

Hankins soils have south-facing slopes and are well drained. They have a surface layer of gray cobbly loam and a subsoil of brown cobbly clay. Tuff is at a depth of 40 inches to more than 60 inches.

Boardtree soils have north-facing slopes and are well drained. They have a surface layer of light brownish-gray gravelly loam and a subsoil of pale-brown gravelly loam. Clay is at a depth of 20 to 40 inches. Depth to bedrock is 40 inches to more than 60 inches.

Yawkey soils have north-facing slopes and are well drained. They have a surface layer of gray gravelly loam or cobbly loam and a subsoil of brown very gravelly clay or very cobbly clay. Basalt is at a depth of 40 to 60 inches.

This association is used for timber production, grazing, wildlife habitat, and water supply. Douglas-fir and ponderosa pine are the main trees used for lumber. Cutover and open areas are used for grazing, mainly by cattle. The wildlife is mainly deer and upland birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is mainly from the steep slopes and cutover areas. Sediment from runoff is low to moderate. Maintaining maximum cover on cutover areas and using protective measures on logging roads and trails minimize the hazard of soil erosion.

2. *Simas-Tub-Curant association*

Moderately deep and deep cobbly silty clay loams, gravelly clay loams, and silt loams

This association consists of soils on narrow ridgetops, steep to very steep soils on the sides of canyons, and moderately steep, rolling soils on uplands (fig. 2). These soils formed in tuff and loess. The vegetation is juniper, bunchgrasses, shrubs, and forbs. Elevation ranges from 1,300 to 4,000 feet. Average annual precipitation ranges from 9 to 14 inches, and average annual air temperature ranges from 44° to 50° F. The frost-free period is 50 to 120 days at 32° and 90 to 150 days at 28°.

This association makes up about 50 percent of the survey area. It is about 35 percent Simas soils, 30 percent Tub soils, and 20 percent Curant soils. Sorf, Day, Rail, Donnybrook, Willowdale, Lithgow, Lithgow series, deep variant, Lickskillet, Degner, McMeen, Gribble, Searles, and Prag soils and Mixed alluvial land, Rock outcrop-Rubble land complex, Rough broken and stony land, and Riverwash make up about 15 percent.

Simas soils are well drained. They have a surface layer of grayish-brown cobbly silty clay loam and a subsoil of brown silty clay. Effective rooting depth is 20 to 40 inches.

Tub soils are well drained. They have a surface layer of gray gravelly clay loam and a subsoil of dark-brown gravelly silty clay or gravelly clay.

Curant soils have north-facing slopes and are well drained. They have a surface layer of dark-gray silt loam and a subsoil of brown silt loam. Colluvium is at a depth of 40 inches to more than 60 inches.

This association is used for range, dryfarmed grain and pasture, wildlife habitat, and water supply. The Tub soils are used mainly for grazing, but some areas are used for grain and improved pasture. The Simas and Curant soils are used for grazing, mainly by cattle. Ranches are large. Springs and ponds are the main source of water.

***Figure 2.*—South-facing area of Simas soils, 8 to 40 percent slopes. Lithgow and Sorf soils, 20 to 50 percent slopes, are in background.**

Wildlife is mainly deer and upland birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is mainly from the steep and very steep Simas and Tub soils, particularly in range areas where the grass is in poor condition. Sediment from runoff is low to moderate. Maintaining maximum cover on rangeland and using soil- and water-conserving practices on dryfarmed cropland minimize the hazard of soil erosion.

3. *Prag-Tub association*

Moderately deep cobbly loams and gravelly clay loams

This association consists of broad areas of rolling soils on ridgetops (fig. 3) between deep, narrow canyons that have steep and very steep sides. These soils formed in tuff. The vegetation is bunchgrasses, shrubs, and forbs. Elevation ranges from 3,000 to 4,500 feet. Average annual precipitation ranges from 13 to 16 inches, and average annual air temperature ranges from 42° to 48° F. The frost-free period is 30 to 70 days at 32° and 90 to 130 days at 28°.

This association makes up about 5 percent of the survey area. It is about 55 percent Prag soils and 25 percent Tub soils. Ginser, Lickskillet, and Rail soils and Rock outcrop-Rubble land complex and Rough broken and stony land make up about 20 percent.

Prag soils have north-facing slopes and commonly are at an elevation of more than 3,500 feet. They have an average annual soil temperature of less than 47°. They are well drained and have a surface layer of dark-gray cobbly loam and a subsoil of grayish-brown or brown cobbly clay. Partially consolidated tuff sediment is at a depth of 20 to 40 inches.

Tub soils have south-facing slopes and have an average annual soil temperature of 48° or warmer. They are well drained and have a surface layer of gray gravelly clay loam and a subsoil of brown gravelly silty clay or gravelly clay.

This association is used for range, wildlife habitat, and water supply. Ranches are large. Springs and ponds are the main source of water. The wildlife is mainly deer and upland birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is mainly from the steep and very steep Tub and Prag soils, particularly in range areas where the grass is in poor condition. Sediment from runoff is low to moderate. Maintaining maximum cover on rangeland minimizes the hazard of soil erosion.

4. *Venator-Utley association*

Shallow to deep shaly loams

This association consists of soils on narrow ridgetops and moderately steep to steep soils on sides of canyons. These soils formed in loess mixed with shale colluvium. The vegetation is bunchgrasses, shrubs, and forbs. Elevation ranges from 3,800 to 4,500 feet. Average annual precipitation is 13 to 16 inches, and average annual air temperature is 42° to 47° F. The frost-free period is 30 to 70 days at 32° and 90 to 125 days at 28°.

This association makes up about 1 percent of the survey area. It is about 50 percent Venator soils and 40 percent Utley soils. Ginser, Degner, and Lickskillet soils make up about 10 percent.

Venator soils have south-facing slopes and are well drained. They have a surface layer of dark grayish-brown shaly loam and a subsoil of dark grayish-brown and brown very shaly heavy clay loam. Fractured shale is at a depth of 10 to 20 inches.

Utley soils have north-facing slopes and are well drained. They have a thick surface layer of dark grayish-

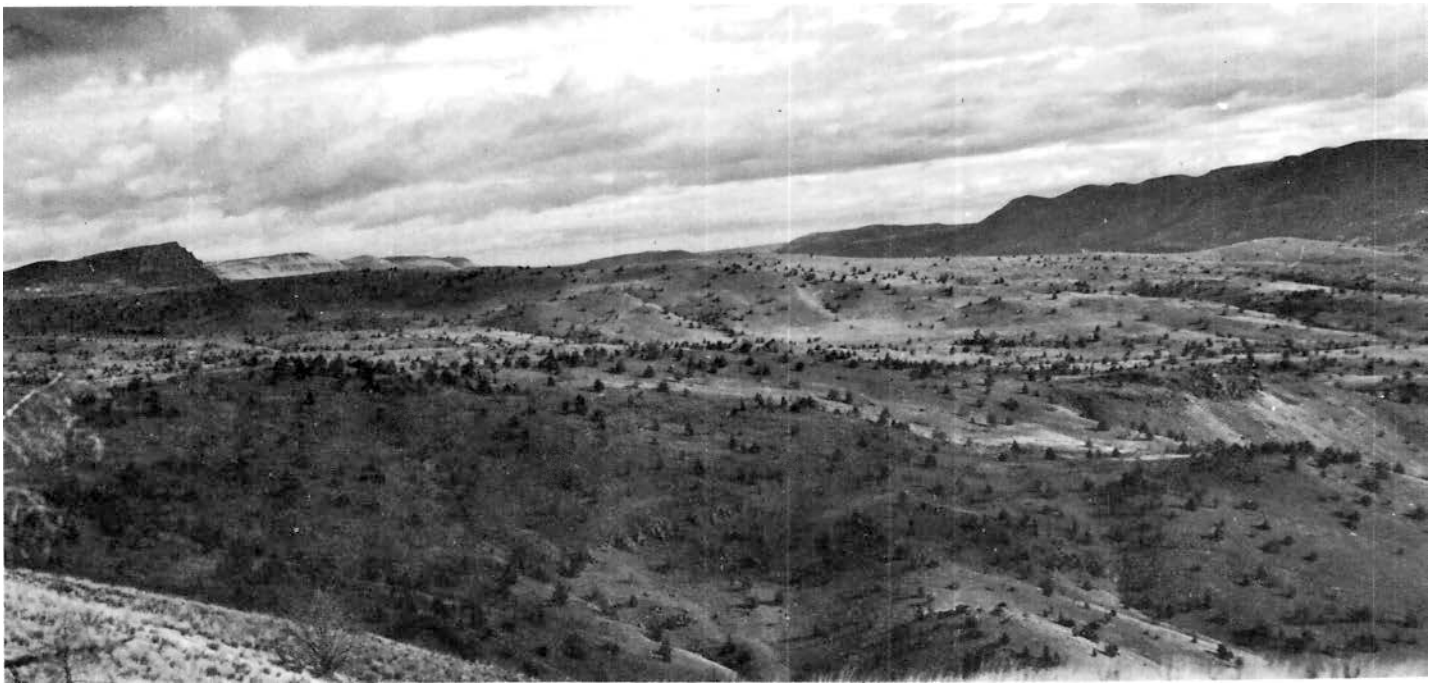

***Figure 3.*—Tub cobbly clay loam, 12 to 40 percent slopes, in broad, rolling areas on ridgetops between deep, narrow canyons.**

brown shaly loam and a subsoil of brown heavy shaly loam. Fractured shale is at a depth of 40 to 60 inches.

This association is used for range, wildlife habitat, and water supply. Ranches are large. Springs are the main source of water. The wildlife is mainly deer and upland birds. Food, cover, and water supply control movement and number of wildlife.

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

5. *Madras-Lamonta-Era association*

Moderately deep and deep loams and cobbly loams

This association consists of broad areas of nearly level to gently sloping and rolling soils on uplands (fig. 4) dissected by narrow drainageways that have steep and very steep sides. These soils formed in mixed eolian and sedimentary materials and are underlain by a hardpan or bedrock. The vegetation is bunchgrasses, shrubs, and forbs. Elevation ranges from 2,000 to 3,300 feet. Average annual precipitation is 9 to 12 inches, and average annual air temperature is 46° to 50° F. The frost-free period is 50 to 80 days at 32° and 100 to 130 days at 28°.

This association makes up about 8 percent of the survey area. It is about 35 percent Madras soils, 15 percent Lamonta soils, and 10 percent Era soils. Agency, McCoin, Metolius, Lickskillet, and Court soils make up about 40 percent.

Madras soils are well drained. They have a surface layer of light brownish-gray loam and a subsoil of light brownish-gray and pale-brown gravelly clay loam. A cobbly, strongly cemented, calcareous hardpan is at a depth of 20 to 30 inches.

Lamonta soils are well drained. They have a surface layer of grayish-brown cobbly loam and a subsoil of brown cobbly clay. A strongly cemented, calcareous hardpan is at a depth of 20 to 30 inches.

Era soils are somewhat excessively drained. They have a surface layer of grayish-brown loam and a subsoil of brown loam. The substratum is brown loam and pale-brown, calcareous sandy loam.

This association is used mainly for range and pasture. It is also used for dryfarmed grain, wildlife habitat, and water supply. Ranches are large, and the water supply for livestock is very limited. Springs, ponds, and wells are the main sources of water. The wildlife is mainly deer and upland birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is mainly from range areas where the grass is in poor condition and from areas of shallow soils. Sediment from runoff is moderate. Maintaining maximum cover on rangeland and using soil- and water-conserving practices on dryfarmed cropland minimize the hazard of soil erosion.

6. *Bakeoven-Lickskillet-Condon association*

Very shallow to moderately deep very cobbly loams, very stony loams, and silt loams

This association consists of broad areas of nearly level and gently sloping soils on ridgetops and steep to very steep soils on the sides of canyons on upland plateaus. These soils formed in wind-laid silt and basalt colluvium. The vegetation is bunchgrasses, forbs, and shrubs. Elevation ranges from 1,000 to 3,600 feet. Average annual precipitation ranges from 10 to 14 inches, and average annual air temperature ranges from 45° to 52° F. The frost-free period is 50 to 150 days at 32° and 100 to 170 days at 28°.

***Figure 4.*—Era soils, 8 to 40 percent slopes, in north-facing areas, associated with Madras soils, 12 to 40 percent slopes.**

This association makes up about 27 percent of the survey area. It is about 50 percent Bakeoven soils, 30 percent Lickskillet soils, and 13 percent Condon soils. Wrentham soils, Playas, Rock outcrop-Rubble land complex, and Riverwash make up about 7 percent.

Bakeoven soils are nearly level, well-drained soils on ridgetops. They have a surface layer of brown very cobbly loam and a subsoil of brown very gravelly heavy loam or very gravelly clay loam. Basalt is at a depth of 4 to 12 inches.

Lickskillet soils have south-facing slopes and are well drained. They have a surface layer of brown very stony loam and a subsoil of brown very stony loam and very stony clay loam. Basalt bedrock is at a depth of 10 to 20 inches.

Condon soils are nearly level soils on ridgetops. They have north-facing slopes and are well drained. The surface layer is grayish-brown silt loam, and the subsoil is brown and pale-brown silt loam. Basalt bedrock is at a depth of 20 to 40 inches.

This association is used for range, dryfarmed grain and pasture, wildlife habitat, and water supply. The Bakeoven and Lickskillet soils are used for grazing, mostly by cattle. Ranches are large, and water supplies for livestock are limited. Springs and ponds are the main sources of water. Dryfarmed small grain is grown principally on the gently sloping Condon soils. The wildlife is mainly deer and upland birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is mainly from the very shallow Bakeoven soils and the steep and very steep Lickskillet soils, particularly in range areas where the grass is in poor condition. Sediment from runoff is low to moderate. Maintaining maximum cover on rangeland and using soil- and water-conserving practices on dryfarmed cropland minimize the hazard of soil erosion.

7. *Wrentham-Lickskillet association*

Shallow and moderately deep silt loams and very stony loams

This association consists of steep to very steep soils on the sides of canyons on upland plateaus (fig. 5). These are shallow and moderately deep soils that formed in wind-laid silt and basalt colluvium. The vegetation is bunchgrasses, forbs, and shrubs. Elevation ranges from 1,000 to 3,600 feet. Average annual precipitation ranges from 10 to 14 inches, and average annual air temperature ranges from 45° to 52° F. The frost-free period is 60 to 150 days at 32° and 100 to 170 days at 28°.

This association makes up about 3 percent of the survey area. It is about 60 percent Wrentham soils and 25 percent Lickskillet soils. Condon soils, Rock outcrop-Rubble land complex, and Riverwash make up about 15 percent.

Wrentham soils have north-facing slopes and are well drained. They have a surface layer of grayish-brown silt loam and a subsoil of brown very cobbly clay loam. Basalt bedrock is at a depth of 20 to 40 inches.

Lickskillet soils have south-facing slopes and are well drained. They have a surface layer of brown very stony loam and a subsoil of brown very stony loam and very stony clay loam. Basalt bedrock is at a depth of 10 to 20 inches.

This association is used for range, wildlife habitat, and water supply. Grazing is mostly by cattle. Ranches are large, and the water supply for livestock is limited. Springs and ponds are the main source of water. The wildlife is mainly deer and upland birds. Food, cover, and water supply control movement and number of wildlife.

Runoff is mainly from the steep and very steep Lickskillet soils, particularly in range areas where the grass is in poor condition. Sediment from runoff is low. Maintaining maximum cover on rangeland minimizes the hazard of soil erosion.

Descriptions of the Soils

This section describes the soil series and mapping units in the Trout Creek-Shaniko Area. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless specifically mentioned otherwise, it is to be assumed that 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. The profile described in the series is representative of mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit. Color terms are for dry soil, unless otherwise stated.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Riverwash, for example, does not belong to a soil series, but nevertheless it is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit, range site, and wildlife group in which the mapping unit has been placed. The page for the description of each capability unit, range site, or wildlife group can be learned 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, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*10*).[1]

[1] Italic numbers in parentheses refer to Literature Cited, p. 81.

Figure 5.—**Steep side slopes of upland canyon. Lickskillet very stony loam, 15 to 40 percent slopes, has south-facing slopes, and Wrentham-Rock outcrop complex, 35 to 70 percent slopes, has north-facing slopes.**

Agency Series

The Agency series consists of well-drained soils that formed in mixed volcanic and water-deposited material on upland plateaus. Slopes are 1 to 12 percent. Elevation is 2,000 to 3,200 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, forbs, shrubs, and juniper. Average annual precipitation is 9 to 11 inches, average annual air temperature is 46° to 50° F., and the frost-free season is 50 to 80 days at 32° and 100 to 130 days at 28°.

In a representative profile the surface layer is light brownish-gray loam about 15 inches thick. The subsoil is pale-brown loam and heavy loam. Basalt bedrock is at a depth of about 32 inches. The soil is neutral throughout.

Permeability is moderately slow. Available water holding capacity is 2 to 7 inches. Water-supplying capacity is 5 to 7 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for range, hay, pasture, dryfarmed small grain, wildlife habitat, and water supply. They are well suited to dryland seedings of grass and legumes for pasture.

Representative profile of Agency loam, 1 to 12 percent slopes, located 300 feet south of U.S. Highway 97 in SE¼SW¼NE¼ sec. 26, T. 9 S., R. 14 E., Jefferson County:

Ap—0 to 4 inches, light brownish-gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; 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. 4 to 8 inches thick.

A3—4 to 15 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; 3 percent pebbles and cobblestones; neutral, clear, smooth boundary. 0 to 12 inches thick.

B21—15 to 21 inches, pale-brown (10YR 6/3) loam, brown (10YR 4/3) moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; 3 percent pebbles and cobblestones; neutral; clear, smooth boundary. 2 to 8 inches thick.

B22—21 to 32 inches, pale-brown (10YR 6/3) heavy loam, brown (10YR 4/3) moist; moderate, medium, subangular blocky structure; hard, friable, sticky and plastic; common fine roots; many, very fine, tubular pores; 5 percent stones, cobblestones, pebbles, and weathered pumice fragments 1 millimeter and smaller in diameter; neutral; abrupt, smooth boundary. 6 to 12 inches thick.

IIR—32 inches, basalt bedrock.

The surface layer is light brownish gray or pale brown when dry and very dark grayish brown or dark brown when moist. It is loam, silt loam, or sandy loam that is 0 to 15 percent pebbles and 3 to 5 percent cobblestones and stones. The subsoil is brown or pale brown when dry and dark brown when moist. It is loam or clay loam that is 3 to 30 percent pebbles and 3 to 5 percent cobblestones and stones. Where the profile is more than 24 inches deep, the lower part of the subsoil is weakly calcareous to moderately calcareous in places. Depth to bedrock is 20 to 40 inches.

Agency loam, 1 to 12 percent slopes (AgC).—This soil is in small, irregularly shaped areas.

Included with this soil in mapping were areas of Metolius, Madras, Era, and Bakeoven soils.

Runoff is slow to medium, and the hazard of erosion is slight to moderate. Capability unit IVe–2; Arid Rolling Hills range site; wildlife group 2.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil name	Area	Extent	Soil name	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Agency loam, 1 to 12 percent slopes	4, 460	0. 5	Lithgow very shaly loam, deep variant, 50 to 70 percent slopes	2, 031	0. 2
Bakeoven very cobbly loam, 2 to 20 percent slopes	47, 344	5. 0	Madras loam, 1 to 12 percent slopes	16, 423	1. 8
Bakeoven-Condon complex, 2 to 20 percent slopes	95, 147	10. 3	Madras soils, 12 to 40 percent slopes	4, 001	. 4
Boardtree and Yawkey gravelly loams, 20 to 70 percent slopes	21, 918	2. 4	McCoin loam, 5 to 20 percent slopes	5, 308	. 6
Condon silt loam, 2 to 12 percent slopes	20, 544	2. 1	McMeen silt loam, 1 to 12 percent slopes	11, 580	1. 1
Condon-Bakeoven complex, 2 to 20 percent slopes	38, 639	4. 2	Metolius sandy loam, 0 to 8 percent slopes	2, 964	. 3
Court sandy loam, 1 to 8 percent slopes	1, 364	. 2	Mixed alluvial land	3, 969	. 4
Curant and Tub silt loams, 8 to 40 percent slopes	48, 031	5. 1	Playas	336	(1)
Curant and Tub silt loams, 40 to 70 percent slopes	48, 101	5. 2	Prag cobbly loam, 5 to 40 percent slopes	20, 738	2. 2
Day clay, 8 to 40 percent slopes	4, 583	. 5	Prag very stony loam, 12 to 50 percent slopes	1, 502	. 2
Degner gravelly loam, 12 to 40 percent slopes	3, 508	. 4	Rail clay	1, 962	. 2
Degner soils, 2 to 12 percent slopes	1, 553	. 2	Riverwash	1, 757	. 2
Donnybrook stony loam, 10 to 40 percent slopes	7, 299	. 8	Rock outcrop-Rubble land complex	6, 318	. 7
Era soils, 1 to 8 percent slopes	3, 915	. 4	Rough broken and stony land	9, 535	1. 0
Era soils, 8 to 40 percent slopes	6, 539	7	Searles very stony loam, 35 to 65 percent slopes	5, 147	. 7
Ginser gravelly silt loam, 12 to 40 percent slopes	2, 271	. 2	Simas cobbly silty clay loam, 10 to 35 percent slopes	76, 205	8. 1
Ginser very stony loam, 35 to 60 percent slopes	7, 076	. 7	Simas very stony clay loam, 35 to 70 percent slopes	43, 920	4. 8
Ginser and Prag soils, 40 to 70 percent slopes	15, 850	1. 7	Simas soils, 8 to 40 percent slopes	15, 784	1. 6
Gribble cobbly loam, 5 to 20 percent slopes	15, 976	1. 7	Sorf very stony loam, 5 to 40 percent slopes	4, 298	. 4
Hankins cobbly loam, 15 to 50 percent slopes	33, 844	3. 7	Tub gravelly clay loam, 1 to 12 percent slopes	30, 347	3. 2
Lamonta cobbly loam, 1 to 12 percent slopes	9, 956	1. 0	Tub cobbly clay loam, 12 to 40 percent slopes	45, 711	4. 8
Lickskillet very stony loam, 15 to 40 percent slopes	46, 633	4. 8	Tub very stony clay loam, 40 to 70 percent slopes	16, 337	1. 8
Lickskillet extremely stony loam, 40 to 70 percent slopes	68, 328	7. 2	Tub very stony soils, 1 to 20 percent slopes	23, 649	2. 5
Lithgow and Sorf soils, 20 to 50 percent slopes	2, 976	. 3	Utley shaly loam, 10 to 50 percent slopes	3, 412	. 4
			Venator shaly loam, 10 to 40 percent slopes	3, 957	. 4
			Willowdale loam	7, 872	. 8
			Wrentham-Rock outcrop complex, 35 to 70 percent slopes	18, 042	1. 9
			Total	938, 960	100. 0

[1] Less than 0.1 percent.

Bakeoven Series

The Bakeoven series consists of well-drained soils that formed on uplands in loess and residuum weathered from basalt. Slopes are 2 to 20 percent. Elevation is 1,600 to 3,600 feet. The vegetation is bunchgrasses, shrubs, and forbs. Average annual precipitation is 10 to 14 inches, average annual air temperature is 45 to 52° F., and the frost-free season is 50 to 140 days at 32° and 100 to 170 days at 28°.

In a representative profile (fig. 6) the surface layer is brown very cobbly loam about 2 inches thick. The subsoil is brown very gravelly loam and very gravelly heavy loam about 5 inches thick. Basalt bedrock is at a depth of about 7 inches. The soil is slightly acid to a depth of 2 inches and neutral between depths of 2 and 7 inches.

Permeability is moderately slow. Available water holding capacity is less than 2.5 inches. Effective rooting depth is 4 to 12 inches.

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

Representative profile of Bakeoven very cobbly loam, 2 to 20 percent slopes, located 50 feet east of county road in SW¼NW¼SW¼ sec. 15, T. 6 S., R. 16 E., Wasco County:

A1—0 to 2 inches, brown (7.5YR 5/3) very cobbly loam, dark brown (7.5YR 3/3) moist; weak, thin, platy structure and weak, fine, granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 20 percent pebbles and 30 percent cobblestones and stones; slightly acid, abrupt, smooth boundary. 0 to 4 inches thick.

B1—2 to 4 inches, brown (7.5YR 5/3) very gravelly loam, dark brown (7.5YR 3/3) moist; weak, fine and medium, granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common, very fine, irregular pores; 40 percent pebbles and 20 percent cobblestones and stones; neutral; abrupt, smooth boundary. 2 to 5 inches thick.

B2—4 to 7 inches, brown (7.5YR 4/3) very gravelly heavy loam, dark brown (7.5YR 3/3) moist; moderate, fine, subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; common, very fine, tubular pores; thin discontinuous clay films on basalt fragments; 40 percent pebbles and 20 percent cobblestones and stones; neutral; abrupt, wavy boundary. 2 to 3 inches thick

IIR—7 inches, basalt bedrock.

The surface layer is grayish brown or brown when dry and very dark grayish brown or dark brown when moist. It is very cobbly loam, very stony loam, or extremely stony loam that is 10 to 30 percent cobblestones or stones and 20 to 50 percent pebbles The subsoil is dark brown to brown when dry and dark brown or dark yellowish brown when moist. It is loam, clay loam, or sandy clay loam that is 10 to 30 percent cobblestones and stones and 40 to 50 percent pebbles. Depth to bedrock is 4 to 12 inches.

Figure 6.—**Area of Bakeoven very cobbly loam, 2 to 20 percent slopes.**

Bakeoven very cobbly loam, 2 to 20 percent slopes (BaC).—This soil is in long, narrow strips between areas of medium-textured Condon soils on ridgetops and areas of steep, very stony Lickskillet soils that have south-facing slopes. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Condon, Agency, Lickskillet, and Wrentham soils.

Runoff is slow to rapid, and the hazard of erosion is slight to moderate. Capability unit VIIs; Scabland range site; wildlife group 1.

Bakeoven-Condon complex, 2 to 20 percent slopes (BcC).—This complex consists of about 50 to 85 percent Bakeoven very cobbly loam, 2 to 20 percent slopes, and 10 to 35 percent Condon silt loam, 2 to 12 percent slopes. The Bakeoven soil is in areas of scabland between and around areas of the Condon soil. The Condon soil commonly is on circular mounds that have a convex surface and are deepest in the center. These mounds are 15 to 40 feet in diameter and about 25 feet apart. Where slopes are more than 10 percent, the Condon soil commonly is on elongated mounds and the long axis is downslope. The soil on the mounds mainly differs from Condon silt loam, 2 to 12 percent slopes, in having a brown surface layer and being as much as 10 percent small basalt fragments.

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

Runoff is slow to rapid, and the hazard of erosion is slight to moderate. Capability unit VIIs; Biscuit-Scabland Complex range site; wildlife group 1.

Boardtree Series

The Boardtree series consists of well-drained soils that formed in volcanic ash over clay on uplands. Slopes are 20 to 70 percent. Elevation is 3,500 to 5,000 feet. The vegetation is Douglas-fir, ponderosa pine, elk sedge, shrubs, and forbs. Average annual precipitation is 16 to 25 inches, average annual air temperature is 40 to 45° F., and the frost-free season is 10 to 50 days at 32° and 80 to 100 days at 28°.

In a representative profile the surface layer is light brownish-gray gravelly loam about 9 inches thick. The subsoil is pale-brown gravelly loam about 7 inches thick. The upper part of the substratum is pale-brown gravelly loam about 15 inches thick. The lower part is brown clay that extends to a depth of 40 inches or more. The soil is slightly acid to a depth of 31 inches and neutral between depths of 31 and 60 inches.

Permeability is moderately rapid to the clay and very slow in the clayey material. Available water holding capacity is 8 to 12 inches. Water-supplying capacity is 15 to 20 inches. Effective rooting depth is 20 to 40 inches, but some roots are below a depth of 40 inches.

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

Representative profile of a Boardtree gravelly loam in an area of Boardtree and Yawkey gravelly loams, 20 to 70 percent slopes, located 100 feet south of road in SE¼NE¼SW¼ sec. 25, T. 11 S., R. 16 E., Jefferson County:

O1—1 inch to 0, twigs, needles, leaves, cones, and grass. 0 to 2 inches thick.

A1—0 to 4 inches, light brownish-gray (10YR 6/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine to medium roots; many, very fine, irregular pores; 25 percent pebbles, 2 to 10 millimeters in diameter; slightly acid; gradual, wavy boundary. 1 to 4 inches thick.

A3—4 to 9 inches, light brownish-gray (10YR 6/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine to medium roots; many, very fine, irregular pores; 25 percent pebbles, 2 to 10 millimeters in diameter; slightly acid; gradual, wavy boundary 4 to 15 inches thick.

B2—9 to 16 inches, pale-brown (10YR 6/3) gravelly loam, dark grayish brown (10YR 4/2) moist; weak, very fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine to coarse roots; many, very fine, tubular pores; 25 percent pebbles, 2 to 10 millimeters in diameter; slightly acid; gradual, wavy boundary. 4 to 10 inches thick.

C—16 to 31 inches, pale-brown (10YR 6/3) gravelly loam, grayish brown (10YR 5/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; many fine to coarse roots; many, very fine, irregular pores; 30 percent pebbles, 2 millimeters to 1 inch in diameter; slightly acid; abrupt, wavy boundary. 6 to 16 inches thick.

IIB2tb—31 to 44 inches, brown (10YR 5/3) clay, dark brown (10YR 3/3) moist; moderate, medium, subangular blocky structure; hard, friable, very sticky and very plastic; few fine and medium roots; many, very fine and fine, tubular pores; 15 percent pebbles, 2 millimeters to 1 inch in diameter; thin, nearly continuous, very dark grayish-brown (10YR 3/2) clay films on peds and in pores; bleached silt coatings on ped surfaces in upper 2 inches; neutral.

The surface layer is light brownish gray or gray when dry and very dark grayish brown or very dark gray when moist. It is loam, gravelly loam, or silt loam that is 5 to 30 percent pebbles. The structure is weak, fine or very fine, granular or subangular blocky. The subsoil is grayish brown or pale brown when dry and dark grayish brown when moist. It is loam, gravelly loam, gravelly silt loam, or gravelly fine sandy loam that is 5 to 30 percent pebbles. The underlying silty clay or clay layer is dark brown or brown when dry and

dark grayish brown or dark brown when moist. It is 5 to 20 percent pebbles Depth to bedrock is 40 inches to more than 60 inches.

Boardtree and Yawkey gravelly loams, 20 to 70 percent slopes (ByF).—This undifferentiated group consists of about 80 percent Boardtree gravelly loam, 20 to 50 percent slopes, and 15 percent Yawkey gravelly loam, 30 to 70 percent slopes. The Boardtree soil is on the middle and lower parts of slopes in areas that are not capped by rock. The Yawkey soil is on the tops and convex parts of areas that are capped by rock.

Included with this undifferentiated group in mapping were areas of Hankins soils that make up about 5 percent of this mapping unit; colder soils that are similar to Boardtree soils but occur at an elevation of more than 5,000 feet; shallow, very stony loams; and very stony, ashy soils that are underlain by bedrock. Rock outcrops commonly are in areas where slopes are more than 50 percent; they make up less than 1 percent of this mapping unit.

Runoff is rapid to very rapid, and the hazard of erosion is high. Capability unit VIIe; Mixed Fir-Pine Forest range site; woodland suitability group 4r; wildlife group 5.

Condon Series

The Condon series consists of well-drained soils that formed in loess mixed with small amounts of volcanic ash on uplands. Slopes are 2 to 12 percent. Elevation is 1,900 to 3,600 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 10 to 14 inches, average annual air temperature is 45 to 52° F., and the frost-free season is 100 to 140 days at 32° and 120 to 170 days at 28°.

In a representative profile the surface layer is grayish-brown silt loam about 7 inches thick. The subsoil is grayish-brown, brown, and pale-brown silt loam about 22 inches thick. Basalt bedrock is at a depth of about 29 inches. The soil is slightly acid to neutral throughout.

Permeability is moderate. Available water holding capacity is 4 to 9 inches. Water-supply capacity is 8 to 10 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for dryfarmed small grain, hay, pasture, range, wildlife habitat, and water supply. They are well suited to dryland seedings of grass and legumes for pasture.

Representative profile of Condon silt loam, 2 to 12 percent slopes, located 70 feet south of Bakeoven County road, 1.6 miles northwest of Wilson Road junction and 11 miles from Maupin in NE¼NE¼SW¼ sec. 2, T. 5 S., R. 15 E., Wasco County:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; slightly acid; abrupt, smooth boundary. 4 to 10 inches thick.

B1—7 to 10 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; 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; slightly acid; clear, wavy boundary. 3 to 10 inches thick.

B21—10 to 18 inches, brown (10YR 5/3) heavy silt loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure and moderate, medium, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, tubular pores; few clay films in pores; neutral; clear, wavy boundary 8 to 10 inches thick.

B22—18 to 29 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; 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; few clay films in pores, neutral; abrupt, wavy boundary. 5 to 13 inches thick.

IIR—29 inches, basalt bedrock.

The surface layer is dark grayish brown or grayish brown when dry and very dark grayish brown or very dark brown when moist. The subsoil is silt loam or heavy silt loam. Where the soil is more than 34 inches deep over bedrock, the subsoil is yellowish brown or pale brown when dry and is loam or sandy loam that in places is weakly calcareous to moderately calcareous. Depth to bedrock is 20 to 40 inches.

Condon silt loam, 2 to 12 percent slopes (CnC).—This soil is in small, irregularly shaped areas. This soil has the profile described as representative of the series.

Included with this soil in mapping were areas of Bakeoven, Wrentham, and Lickskillet soils and areas of Condon soils that have 12 to 20 percent slopes.

Runoff is slow to medium, and the hazard of erosion is slight to moderate. Capability unit IIIe–1; Rolling Hills range site; wildlife group 1.

Condon-Bakeoven complex, 2 to 20 percent slopes (CoC).—This complex consists of about 50 to 95 percent Condon silt loam, 2 to 12 percent slopes, and 10 to 35 percent Bakeoven very cobbly loam, 2 to 20 percent slopes. The Condon soil is in long, narrow areas, and its long axis is downslope. The Bakeoven soil is in areas of scabland between and around areas of the Condon soil.

Included with this complex in mapping were areas of Lickskillet and Wrentham soils that make up as much as 15 percent of this mapping unit. Also included were areas of shallow, stony soils.

Runoff is slow to rapid, and the hazard of erosion is slight to moderate. Capability unit VIe; Biscuit-Scabland Complex range site; wildlife group 1.

Court Series

The Court series consists of well-drained soils that formed on alluvial fans in alluvium of mixed origin, including pumice and ash. Slopes are 1 to 8 percent. Elevation is 2,500 to 3,000 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, shrubs, forbs, and juniper. Average annual precipitation is 9 to 11 inches, average annual air temperature is 46 to 49° F., and the frost-free season is 50 to 80 days at 32° and 100 to 130 days at 28°.

In a representative profile the surface layer is grayish-brown sandy loam about 14 inches thick. The upper part of the subsoil is brown sandy loam about 9 inches thick. The lower part is pale-brown loam about 6 inches thick. The substratum is pale-brown very gravelly loamy sand. The soil is neutral to a depth of 29 inches and moderately alkaline below that depth.

Permeability is moderately rapid. Available water holding capacity is 3 to 6 inches. Water-supplying capa-

city is 5 to 7 inches. Effective rooting depth is 20 to 40 inches.

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

Representative profile of Court sandy loam, 1 to 8 percent slopes, located about 100 feet from center of gravel road in SW¼SE¼NW¼ sec. 33, T. 13 S., R. 14 E., Jefferson County:

AP—0 to 5 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; very weak, thick, platy structure; hard, friable, nonsticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 15 percent pumice sand; neutral; gradual, smooth boundary. 3 to 6 inches thick.

A1—5 to 14 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; very weak, medium, subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; many very fine roots; many, very fine, tubular pores; 15 percent pumice sand; neutral; clear, smooth boundary. 8 to 12 inches thick.

B21—14 to 23 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; very weak, medium, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, tubular pores; 15 percent pumice sand, neutral; clear, smooth boundary. 4 to 12 inches thick.

IIB22—23 to 29 inches, pale-brown (10YR 6/3) loam, brown (10YR 4/3) moist; moderate, fine, subangular blocky structure; hard, friable, slightly sticky and plastic; many very fine roots; many, very fine, tubular pores; 8 percent pebbles and 2 percent cobblestones; neutral, abrupt, irregular boundary 0 to 10 inches thick.

IIICca—29 to 38 inches, pale-brown (10YR 6/3) very gravelly loamy sand, brown (10YR 4/3) moist; massive; hard in place and loose when disturbed, nonsticky and nonplastic; 60 percent pebbles and 10 percent cobblestones; strongly calcareous; moderately alkaline.

The surface layer is grayish brown or brown when dry and very dark grayish brown or dark brown when moist. It is sandy loam or fine sandy loam that is 0 to 20 percent pebbles The subsoil is brown or pale brown when dry and dark brown or brown when moist. It is sandy loam or loam and is 0 to 20 percent pebbles and cobblestones. The substratum is light brownish gray or pale brown when dry and dark brown when moist It is very gravelly loamy sand that is 55 to 65 percent pebbles and 10 to 15 percent cobblestones. The substratum is weakly calcareous to strongly calcareous. Depth to bedrock is more than 60 inches

Court sandy loam, 1 to 8 percent slopes (CrB).—This soil is in irregularly shaped areas on broad alluvial fans.

Included with this soil in mapping were areas of Metolius, Lamonta, and McCoin soils.

Runoff is slow, and the hazard of erosion is slight. Capability unit IVe–1; Droughty Bottomland Fan range site; wildlife group 2.

Curant Series

The Curant series consists of well-drained soils that formed in loess on uplands. Slopes are 8 to 70 percent. Elevation is 2,200 to 3,700 feet. The vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 10 to 14 inches, average annual air temperature is 45 to 49° F., and the frost-free season is 50 to 70 days at 32° and 90 to 130 days at 28°.

In a representative profile the surface layer is dark-gray silt loam about 16 inches thick. The subsoil is brown silt loam and heavy silt loam about 17 inches thick. The substratum is pale-brown silt loam about 27 inches thick. The soil is neutral to a depth of 33 inches, mildly alkaline between depths of 33 and 39 inches, and moderately alkaline below a depth of 39 inches.

Permeability is moderate. Available water holding capacity is 9 to 12 inches. Water-supplying capacity is 8 to 10 inches. Effective rooting depth is 60 inches or more.

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

Representative profile of a Curant silt loam in an area of Curant and Tub silt loams, 8 to 40 percent slopes, located 200 feet east of farm road in NE¼NW¼NE¼ sec. 25, T. 8 S., R. 16 E., Wasco County:

A11—0 to 4 inches, dark-gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) moist; weak, thin and medium, platy structure and weak, fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; neutral; abrupt, smooth boundary. 2 to 4 inches thick.

A12—4 to 16 inches, dark-gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) moist; weak, coarse, prismatic structure and moderate, medium, subangular blocky; hard, friable, slightly sticky and slightly plastic, many very fine roots; many, very fine, tubular pores; neutral; clear, wavy boundary. 6 to 12 inches thick

B2—16 to 25 inches, brown (10YR 5/3) heavy silt loam, dark brown (10YR 3/3) moist; weak, medium and coarse, prismatic structure and moderate, medium, subangular blocky; hard, friable, sticky and slightly plastic; many very fine roots, many, very fine, tubular pores; few, thin, very dark brown coatings on peds; few dark krotovinas; neutral; clear, wavy boundary 5 to 15 inches thick.

B3—25 to 33 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure and weak, medium, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, tubular pores; few hard nodules, ½ to 1 inch in diameter; few dark krotovinas; neutral; clear, wavy boundary. 6 to 12 inches thick

IIC1—33 to 39 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; 5 percent pebbles; mildly alkaline; clear, wavy boundary. 0 to 10 inches thick.

IIC2ca—39 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many, very fine, tubular pores; 15 percent pebbles; strongly calcareous and has light-gray segregations of lime; moderately alkaline.

The surface layer is dark grayish brown or dark gray when dry and very dark brown or very dark grayish brown when moist. It is silt loam or very fine sandy loam and is 0 to 5 percent pebbles. The subsoil is brown or pale brown when dry and dark brown or brown when moist. It is silt loam to light silty clay loam that is 20 to 32 percent clay and 0 to 15 percent pebbles. The substratum is pale brown or light brownish gray when dry and grayish brown or brown when moist. It is silt loam, very fine sandy loam, or loam that is 5 to 35 percent pebbles. Depth to bedrock is more than 60 inches.

Curant and Tub silt loams, 8 to 40 percent slopes (CtE).—This undifferentiated group consists of about 45 to 55 percent Curant soils and 35 to 40 percent Tub soils. These soils have north-facing slopes. The Curant soil has the profile described as representative of the Curant series. The Tub soil has a profile similar to the one

described as representative of the Tub series, but the surface layer is nongravelly silt loam 2 to 6 inches thick.

Included with this undifferentiated group in mapping were areas of very stony soils, shallow very stony soils, Degner soils, and rock outcrops that make up as much as 15 percent of areas of this mapping unit.

Runoff is medium to rapid, and the hazard of erosion is moderate. Capability unit VIe; North Exposure range site; wildlife group 4.

Curant and Tub silt loams, 40 to 70 percent slopes (CtF).—This undifferentiated group consists of about 55 to 75 percent Curant soils and 15 to 30 percent Tub soils. These soils occur in a variable pattern in long, narrow areas and generally have north-facing slopes. They commonly occur together where slopes are northwest-facing, and in some areas where slopes are north- and northeast-facing, the Tub soil is not present. The Curant soil has the profile described as representative of the Curant series. The Tub soil has a profile similar to the one described as representative of the Tub series, but the surface layer is nongravelly silt loam 2 to 12 inches thick.

Included with this group in mapping were areas of moderately deep silt loam over clay, very stony shallow soils, Degner soils, and rock outcrops that make up as much as 15 percent of areas of this mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability unit VIIe; Steep North range site; wildlife group 4.

Day Series

The Day series consists of well-drained soils that formed in old calcareous clay on uplands. Slopes are 8 to 40 percent. Elevation is 1,300 to 3,500 feet. The vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 9 to 14 inches, average annual air temperature is 45 to 52° F., and the frost-free season is 60 to 120 days at 32° and 100 to 150 days at 28°.

In a representative profile the surface layer is dark reddish-brown clay about 3 inches thick. The underlying layer is dark reddish-brown, dark-red, and red clay that extends to a depth of 40 inches or more. The soil is neutral to a depth of 17 inches, moderately alkaline between depths of 17 and 32 inches, and strongly alkaline below a depth of 32 inches.

Permeability is very slow. Available water holding capacity is 6 to 10 inches. Water-supplying capacity is 6 to 8 inches. Effective rooting depth is 40 to 60 inches.

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

Representative profile of Day clay, 8 to 40 percent slopes, located 350 feet south of road in SE¼NW¼SE¼ sec. 19, T. 8 S., R. 18 E., Wasco County:

A1—0 to 3 inches, dark reddish-brown (2.5YR 3/4) clay, dark red (2.5YR 3/6) moist; strong, very fine, granular structure; very hard, friable, very sticky and very plastic; common very fine roots; many, very fine irregular pores; neutral; abrupt, smooth boundary. 2 to 4 inches thick

AC1—3 to 17 inches, dark reddish-brown (2.5YR 3/4) clay, dark reddish brown (2.5YR 3/4) moist; strong, coarse, prismatic structure and moderate, medium, angular blocky; extremely hard, very firm, very sticky and very plastic, common very fine roots; many, very fine, tubular pores; many intersecting slickensides; neutral; clear, smooth boundary. 8 to 15 inches thick.

AC2—17 to 25 inches, dark-red (2.5YR 3/6) clay, dark red (2.5YR 3/6) moist, moderate, coarse, prismatic structure and weak, coarse, angular blocky; extremely hard, very firm, very sticky and very plastic; common very fine roots; many, very fine, tubular pores; many intersecting slickensides; moderately alkaline, weakly calcareous; clear, smooth boundary. 8 to 15 inches thick.

C1ca—25 to 32 inches, dark-red (2.5YR 3/6) clay, dark red (2.5YR 3/6) moist; moderate, medium, angular blocky aggregates; extremely hard, very firm, very sticky and very plastic; few very fine roots; few, very fine, tubular pores; moderately alkaline; moderately calcareous; clear, smooth boundary. 6 to 26 inches thick.

C2ca—32 to 40 inches, red (2.5YR 4/5) clay, dark red (2.5YR 3/6) moist, strong, fine, angular blocky aggregates; extremely hard, extremely firm, very sticky and very plastic; very few fine roots; few, very fine, tubular pores; common, fine, mycellium lime deposits; strongly alkaline; moderately calcareous.

The surface layer is dark reddish brown, reddish brown, or dark red when dry and dark reddish brown or dark red when moist. It is 0 to 5 percent pebbles. The structure is strong, very fine or fine, granular. The underlying layers are red dark red, reddish brown, dark reddish brown, or dusky red when dry and dark red or dusky red when moist. They are 0 to 5 percent pebbles. The structure is moderate or strong, blocky or prismatic Depth to lime is 10 to 24 inches.

Day clay, 8 to 40 percent slopes (DaE).—This soil is in small, irregularly shaped areas in saddles, at heads of drainageways, and in severely eroded areas.

Included with this soil in mapping were areas of Tub, Curant, and Simas soils and areas of gray, clayey soils.

Runoff is slow until the soil becomes saturated, and then runoff is rapid. The hazard of erosion is high. Capability unit VIIe; Adobeland range site; wildlife group 4.

Degner Series

The Degner series consists of well-drained soils that formed in colluvium on uplands. Slopes are 2 to 40 percent. Elevation is 2,200 to 3,600 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, forbs, shrubs, and juniper. Average annual precipitation is 11 to 14 inches, average annual air temperature is 45 to 49° F., and the frost-free season is 50 to 70 days at 32° and 90 to 130 days at 28°.

In a representative profile (fig. 7) the surface layer is gray and dark-gray gravelly loam about 13 inches thick. The upper part of the subsoil is dark grayish-brown gravelly light clay about 5 inches thick. The lower part is brown very gravelly clay about 9 inches thick. The substratum is pale-brown very gravelly loam about 13 inches thick over bedrock. The soil is neutral to a depth of 27 inches and moderately alkaline between depths of 27 and 40 inches.

Permeability is moderately slow. Available water holding capacity is 4 to 9 inches. Water-supplying capacity is 6 to 8 inches. Effective rooting depth is 40 to 60 inches.

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

Representative profile of Degner gravelly loam, 12 to 40 percent slopes, located 350 feet west of road in

Figure 7.—**Profile of a Degner gravelly loam underlain by bedrock at a depth of 40 inches.**

SE¼NW¼SW¼ sec. 32, T. 9 S., R. 17 E., Jefferson County:

A11—0 to 3 inches, gray (10YR 5/1) gravelly loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 20 percent pebbles; neutral; clear, smooth boundary. 3 to 8 inches thick.

A12—3 to 13 inches, dark-gray (10YR 4/1) gravelly heavy loam, very dark brown (10YR 2/2) moist; weak, fine, subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine roots; many, very fine, tubular pores; 25 percent pebbles; neutral; clear, smooth boundary 6 to 12 inches thick

B21t—13 to 18 inches, dark grayish-brown (10YR 4/2) gravelly light clay, dark brown (10YR 3/3) moist; moderate, fine, subangular blocky structure; hard, firm, sticky and very plastic, many very fine roots; many, very fine, tubular pores, few thin clay films; 25 percent pebbles; neutral; abrupt, smooth boundary. 5 to 10 inches thick.

IIB22t—18 to 27 inches, brown (10YR 5/3) very gravelly clay, dark brown (10YR 4/3) moist; weak, medium, subangular blocky structure; very hard, firm, very sticky and very plastic, few very fine roots; many, very fine, tubular pores; many, thick, dark-brown (10YR 3/3) clay films; 50 percent pebbles and 10 percent cobblestones, neutral; abrupt, wavy boundary. 6 to 12 inches thick.

IIICca—27 to 40 inches, pale-brown (10YR 6/3) very gravelly loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; 50 percent pebbles and 10 percent cobblestones; strongly calcareous; moderately alkaline.

IIIR—40 inches, bedrock.

The surface layer is gray, dark gray, or grayish brown when dry and very dark brown, black, or very dark grayish brown when moist. It is gravelly loam, gravelly silt loam, or silt loam that is 0 to 25 percent pebbles. Structure in the surface layer is granular or subangular blocky. The subsoil is grayish brown, brown, or dark grayish brown when dry and dark brown, brown, or very dark gayish brown when moist It is gravelly or very gravelly clay that is 40 to 60 percent clay, 25 to 60 percent pebbles, and 5 to 10 percent cobblestones The substratum is gravelly or very gravelley loam, clay loam, or clay that is 25 to 60 percent pebbles and 5 to 10 percent cobblestones. The substratum is weakly calcareous to strongly calcareous. Depth to bedrock is 40 to 60 inches

Degner gravelly loam, 12 to 40 percent slopes (DeE).—This soil is in irregularly shaped areas and has north-facing slopes. This soil has the profile described as representative of the series.

Included with this soil in mapping were areas of Tub, Donnybrook, and Curant soils; shallow, very stony soils; and rock outcrops.

Runoff is medium to rapid, and the hazard of erosion is moderate to high. This soil is used for range, pasture, wildlife habitat, and water supply. Capability unit VIe; Shrubby North Exposure range site; wildlife group 4.

Degner soils, 2 to 12 percent slopes (DgC).—This undifferentiated group consists of about 45 percent Degner gravelly loam and 40 percent soils that are moderately deep loam or clay loam underlain by tuff at a depth of 20 to 40 inches, and very gravelly clay loam or cobbly clay loam underlain by tuff at a depth of 12 to 20 inches. These soils are on uplands.

Included with these soils in mapping were areas of Lamonta, McCoin, Tub, and Gribble soils that make up as much as 15 percent of areas of this mapping unit.

Runoff is medium, and the hazard of erosion is moderate. These soils are used for dryfarmed small grain, hay, range, pasture, wildlife habitat, and water supply. Capability unit VIe; Shrubby Rolling Hills range site; wildlife group 4.

Donnybrook Series

The Donnybrook series consists of well-drained soils that formed in loess mixed with colluvium on uplands. Slopes are 10 to 40 percent. Elevation is 2,500 to 4,000 feet. The vegetation is bunchgrasses, forbs, shrubs, and juniper. Average annual precipitation is 11 to 14 inches, average annual air temperature is 44 to 49° F., and the frost-free season is 60 to 80 days at 32° and 110 to 130 days at 28°.

In a representative profile the surface layer is grayish-brown stony loam about 5 inches thick. The subsoil is brown gravelly sandy clay loam about 13 inches thick. Slightly weathered tuff is at a depth of about 18 inches. The soil is neutral to a depth of 10 inches and moderately alkaline between depths of 10 and 18 inches.

Permeability is moderately slow. Available water holding capacity is 2 to 3 inches. Water-supplying capacity is about 6.5 inches. Effective rooting depth is 12 to 20 inches.

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

Representative profile of Donnybrook stony loam, 10 to 40 percent slopes, located about 2,310 feet north and 45 feet west of the southeast corner and 300 feet north of the center of a gravel road in NE¼SE¼ sec. 31, T. 9 S., R. 17 E., Jefferson County:

A1—0 to 5 inches, grayish-brown (10YR 5/2) stony loam, dark brown (10YR 3/3) moist; weak, thin, platy structure and moderate, very fine, granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores, 20 percent pebbles and 5 percent stones; neutral; abrupt, smooth boundary. 3 to 6 inches thick.

B2—5 to 10 inches, brown (10YR 5/3) gravelly sandy clay loam, dark brown (10YR 3/3) moist; weak to moderate, medium, subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; 20 percent pebbles and 5 percent stones; neutral; clear, smooth boundary. 5 to 12 inches thick.

B3ca—10 to 18 inches, brown (10YR 5/3) gravelly sandy clay loam, dark brown (10YR 4/3) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; 20 percent pebbles and 5 percent stones; strongly calcareous; moderately alkaline; abrupt, wavy boundary. 4 to 10 inches thick

IIC—18 to 22 inches, light brownish-gray (10YR 6/2), slightly weathered, coarse-grained tuff, dark yellowish brown (10YR 4/4) moist.

The surface layer is grayish brown or brown when dry and very dark grayish brown or dark brown when moist It is a gravelly loam or silt loam. The subsoil is brown or pale brown when dry and dark brown or brown when moist. It is gravelly heavy loam, gravelly clay loam, or gravelly sandy clay loam that is 18 to 30 percent clay. The soil ranges from 20 to 30 percent pebbles. As much as 5 percent stones occur throughout the profile Free lime is at a depth of 10 to 18 inches. Depth to weathered tuff is 12 to 20 inches.

Donnybrook stony loam, 10 to 40 percent slopes (DoE).—This soil has south-facing slopes and is in long, narrow areas on ridges.

Included with this soil in mapping were areas of Degner soils, Tub soils, and shallow, very stony soils.

Runoff is medium to rapid, and the hazard of erosion is moderate to high. Capability unit VIe; Shrubby South Exposure range site; wildlife group 6.

Era Series

The Era series consists of somewhat excessively drained soils that formed on uplands in an eolian material of mixed origin, including pumice and ash. Slopes are 1 to 40 percent. Elevation is 2,000 to 3,000 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 9 to 12 inches, average annual air temperature is 46 to 50° F., and the frost-free season is 50 to 80 days at 32° and 100 to 130 days at 28°.

In a representative profile the surface layer is grayish-brown loam about 8 inches thick. The subsoil is brown loam about 15 inches thick. The upper part of the substratum is brown loam about 14 inches thick. The lower part is pale-brown sandy loam about 11 inches thick. The soil is mildly alkaline to a depth of 23 inches and strongly alkaline or very strongly alkaline between depths of 23 and 48 inches.

Permeability is moderately rapid. Available water holding capacity is 5 to 11 inches. Water-supplying capacity is 6 to 7 inches. Effective rooting depth is 40 to 60 inches.

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

Representative profile of an Era soil in an area of Era soils, 8 to 40 percent slopes, located about 15 feet east of the north-south fence and 1,320 feet north and 1,200 feet east of the southwest corner of sec. 34, T. 11 S., R. 14 E., Jefferson County:

Ap—0 to 3 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium, platy structure and weak, very fine, granular; loose, very friable, slightly sticky and slightly plastic; many very fine roots; few, very fine, irregular pores; common pumice sand grains; mildly alkaline; clear, wavy boundary. 3 to 6 inches thick.

A1—3 to 8 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure and weak, coarse, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine and fine, tubular pores; 20 percent pumice; mildly alkaline; clear, smooth boundary. 4 to 6 inches thick.

B2—8 to 23 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure and weak, coarse, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine and fine, tubular pores; 20 percent pumice; mildly alkaline; clear, smooth boundary. 10 to 15 inches thick.

C1—23 to 37 inches, brown (10YR 5/3) loam, brown (10YR 3/3) moist; massive; slightly hard, very friable; common very fine roots; few, very fine, tubular pores; weakly calcareous; 20 percent pumice; strongly alkaline; gradual, smooth boundary. 10 to 15 inches thick.

C2ca—37 to 48 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 3/3) moist; massive; soft, very friable; few very fine roots; 20 percent pumice; moderately calcareous; few light-gray lime seams; 5 percent lime-coated pebbles; very strongly alkaline.

The surface layer is grayish brown or brown when dry and very dark grayish brown or dark brown when moist. It is loam, sandy loam, or fine sandy loam. The subsoil is brown or pale brown when dry and dark brown, dark grayish brown, or brown when moist. It is sandy loam or loam. Structure is weak, coarse, prismatic to weak, coarse, subangular blocky. The subsoil is neutral to strongly alkaline. The substratum is brown, very dark grayish brown, dark grayish brown, or brown when moist. It is coarse sandy loam to loam. It is mildly alkaline to very strongly alkaline. Pumice makes up 10 to 25 percent of the profile, and pebbles make up 0 to 10 percent. Depth to tuff, basalt, or coarse colluvial material is 40 to 60 inches.

Era soils, 1 to 8 percent slopes (ErB).—This undifferentiated group consists of about 50 percent Era soils and 35 percent shallow, very stony, clayey soils; shallow, very

stony, loamy soils; and moderately deep sandy loams or loams over clayey material, very gravelly or cobbly material, or bedrock.

Included with this group in mapping were areas of Agency and Madras soils that make up as much as 15 percent of this mapping unit.

Runoff is slow, and the hazard of erosion is slight. Capability unit IVe–1; Sand Hills range site; wildlife group 2.

Era soils, 8 to 40 percent slopes (ErE).—This undifferentiated group consists of about 50 percent Era soils and about 35 percent shallow, very stony, clayey soils; shallow, very stony, loamy soils; and moderately deep sandy loams or loams over clayey material, very gravelly or cobbly material, or bedrock. These are moderately steep soils that have north-facing slopes and are in long, narrow areas. The Era soil has the profile described as representative of the series.

Included with this group in mapping were areas of Agency and Madras soils that make up as much as 15 percent of this mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit VIe; Sandy North Exposure range site; wildlife group 2.

Ginser Series

The Ginser series consists of well-drained soils that formed in loess mixed with colluvium on uplands. Slopes are 12 to 70 percent. Elevation is 3,500 to 4,500 feet. The vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 13 to 16 inches, average annual air temperature is 42 to 45° F., and the frost-free season is 30 to 60 days at 32° and 90 to 110 days at 28°.

In a representative profile the surface layer is dark grayish-brown gravelly silt loam about 14 inches thick. The upper part of the subsoil is dark-brown gravelly silt loam about 11 inches thick. The lower part is dark yellowish-brown very gravelly silty clay loam about 8 inches thick. The substratum is weathered tuff. Reaction is slightly acid to a depth of 14 inches, medium acid between depths of 14 and 25 inches, and slightly acid below a depth of 25 inches.

Permeabiilty is moderately slow. Available water holding capacity is 3 to 6 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 Ginser gravelly silt loam, 12 to 40 percent slopes, located about 2,640 feet south and 1,100 feet east of the northwest corner in SE¼SW¼ NW¼ sec. 34, T. 10 S., R. 16 E., Jefferson County:

A11—0 to 6 inches, dark grayish-brown (10YR 4/2) gravelly silt loam, black (10YR 2/1) moist; weak, medium, platy structure and moderate, fine, granular; soft, very friable; slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 20 percent angular pebbles; slightly acid; clear, smooth boundary. 3 to 9 inches thick.

A12—6 to 14 inches, dark grayish-brown (10YR 4/2) gravelly silt loam, very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure and moderate, fine, granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, tubular pores; 20 percent angular pebbles; slightly acid; gradual, smooth boundary. 5 to 10 inches thick.

B1—14 to 25 inches, dark-brown (10YR 4/3) gravelly silt loam, dark brown (10YR 3/3) moist; moderate, medium, subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; many, fine and very fine, tubular pores; 30 percent angular pebbles; few very dark brown krotovinas; medium acid; clear, smooth boundary. 0 to 12 inches thick.

B2—25 to 33 inches, dark yellowish-brown (10YR 4/4) very gravelly silty clay loam, dark yellowish brown (10YR 3/4) moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few roots; many, very fine, tubular pores; 60 percent pebbles and 15 percent cobblestones; few thin clay films on coarse fragments; slightly acid; abrupt, smooth boundary. 6 to 9 inches thick.

IIC—33 inches, grayish-brown (2.5Y 5/2) and olive-gray (5Y 5/2) weathered tuff, olive brown (2.5Y 4/4) and olive (5Y 4/4) moist; massive; very hard, firm, very sticky and very plastic; few roots in upper part.

The surface layer is very dark gray, very dark grayish brown, or dark grayish brown when dry and black or very dark brown when moist It is 20 to 30 percent pebbles and as much as 10 percent cobblestones. The subsoil is dark brown, dark yellowish brown, or yellowish brown when dry and dark brown or dark yellowish brown when moist. It is generally very gravelly silty clay loam but in places is gravelly silt loam Clay makes up 25 to 35 percent of the subsoil. The lower part of the subsoil is 50 to 60 percent angular pebbles and 10 to 20 percent cobblestones. Depth to tuff is 20 to 40 inches.

Ginser gravelly silt loam, 12 to 40 percent slopes (GgE).—This soil has long, narrow, north-facing slopes. This soil has the profile described as representative of the series.

Included with this soil in mapping were areas of Prag soils and very stony shallow soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit VIe; North Exposure range site; wildlife group 4.

Ginser very stony loam, 35 to 60 percent slopes (GnF).—This soil has south-facing slopes and is in irregularly shaped areas. It has a profile similar to the one described as representative of the series, but it contains more stones and has a surface layer of loam.

Included with this group in mapping were areas of shallow, very stony, loamy soils and Hankins, Boardtree, and Yawkey soils.

Runoff is rapid, and the hazard of erosion is high. Capability unit VIIs; Steep South range site; wildlife group 6.

Ginser and Prag soils, 40 to 70 percent slopes (GpF).—This undifferentiated group consists of about 45 to 55 percent Ginser soils and about 35 to 40 percent Prag soils. These soils have north-facing slopes and are in long, narrow areas in various combinations or alone. The Ginser soil has a profile similar to the one described as representative of the series, but the surface layer is as much as 50 percent angular basalt stones. The Prag soil has a profile similar to the one described as representative of the Prag series, but the surface layer is 30 to 35 percent angular basalt stones.

Included with this group in mapping were areas of very stony, shallow, loamy soils; shallow, clayey soils; Curant soils; and rock outcrops that make up as much as 15 percent of the mapping unit.

Runoff is rapid, and the hazard of erosion is high. Capability unit VIIe; Steep North range site; wildlife group 4.

Gribble Series

The Gribble series consists of well-drained soils that formed in colluvium on uplands. Slopes are 5 to 20 percent. Elevation is 3,300 to 3,900 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, forbs, shrubs, and junipers. Average annual precipitation is 12 to 14 inches, average annual air temperature is 45 to 47° F., and the frost-free season is 50 to 70 days at 32° and 90 to 110 days at 28°.

In a representative profile the upper part of the surface layer is dark-gray cobbly loam about 3 inches thick. The lower part is very dark gray cobbly clay loam about 7 inches thick. The upper part of the subsoil is dark-gray and grayish-brown cobbly clay about 17 inches thick. The lower part is brown very cobbly silty clay about 3 inches thick. The upper part of the substratum is light yellowish-brown very cobbly clay loam about 7 inches thick. A very pale brown, silica-cemented, gravelly and cobbly hardpan is at a depth of about 37 inches. The soil is slightly acid to a depth of 3 inches, neutral between depths of 3 and 27 inches, mildly alkaline between depths of 27 and 30 inches, and moderately alkaline between depths of 30 and 37 inches.

Permeability is very slow. Available water holding capacity is 2 to 5 inches. Water-supplying capacity is 6 to 8 inches. Effective rooting depth is 20 to 40 inches.

This soil is used for range, pasture, dryfarmed small grain, wildlife habitat, and water supply.

Representative profile of Gribble cobbly loam, 5 to 20 percent slopes, located 100 feet west of Bonneville Power Administration power pole number 4 in NW¼NE¼SE¼ sec. 13, T. 13 S., R. 14 E., Jefferson County:

A11—0 to 3 inches, dark-gray (10YR 4/1) cobbly loam, black (10YR 2/1) moist; weak, thin, platy structure and moderate, fine, granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 10 percent pebbles and 15 percent cobblestones; slightly acid; clear, wavy boundary. 3 to 6 inches thick.

A12—3 to 10 inches, very dark gray (10YR 3/1) cobbly clay loam, black (10YR 2/1) moist; moderate, very fine and fine, subangular blocky structure; hard, friable, sticky and plastic; many very fine and fine roots; many, very fine, tubular pores; 10 percent pebbles and 20 percent cobblestones; neutral; clear, wavy boundary 4 to 8 inches thick

B21t—10 to 15 inches, dark-gray (10YR 4/1) cobbly clay, very dark gray (10YR 3/1) moist; strong, medium and fine, blocky structure; extremely hard, very firm, very sticky and very plastic; common very fine and medium roots; many, very fine, tubular pores; thick continuous clay films or pressure faces; 30 percent cobblestones and 15 percent pebbles; neutral; clear, irregular boundary. 4 to 10 inches thick

B22t—15 to 27 inches, grayish-brown (10YR 5/2) cobbly clay, dark grayish brown (10YR 4/2) moist; strong, medium roots; many, very fine, tubular pores; thick, continuous, very dark grayish-brown (10YR 3/2) clay films; 30 percent cobbestones and 15 percent pebbles; few slickensides that do not intersect; neutral; clear, irregular boundary. 7 to 15 inches thick.

B23t—27 to 30 inches, brown (10YR 5/3) very cobbly silty clay, dark brown (10YR 4/3) moist; moderate, medium, subangular blocky structure; extremely hard, friable, sticky and plastic; common fine roots; many, very fine, tubular pores; thick continuous clay films or pressure faces; few slickensides; thick lime coatings on lower surfaces of peds and under rock fragments; 35 percent cobblestones and 20 percent pebbles; weakly calcareous; mildly alkaline; clear, irregular boundary 0 to 6 inches thick.

IIC1ca—30 to 37 inches, light yellowish-brown (10YR 6/4) very cobbly clay loam, yellowish brown (10YR 5/4) moist; massive; very hard, very firm, sticky and plastic; few very fine roots; many, very fine, tubular pores; thick clay films in pores; 40 percent cobblestones and 20 percent pebbles; myceliumlike lime veins and lime deposits on lower sides of fragments; moderately calcareous; moderately alkaline; clear, smooth boundary 3 to 8 inches thick.

IIC2sim—37 to 43 inches, very pale brown (10YR 7/3), silica-cemented, gravelly and cobbly hardpan, brown (10YR 4/3) moist; massive; weakly and strongly cemented, very hard, very firm; about one-third of surface of hardpan is indurated and coated with opal or opal and sesquioxides.

The surface layer is dark gray, gray, or very dark gray when dry. It is cobbly clay loam, cobbly silty clay loam, or cobbly loam that is 10 to 25 percent cobblestones and 10 to 20 percent pebbles Structure in the surface layer is weak, platy to moderate, granular and very fine and fine, subangular blocky. The subsoil is grayish brown, dark gray, or brown when dry and very dark gray, dark grayish brown, or dark brown when moist It is cobbly clay, very cobbly clay, cobbly silty clay, or very cobbly silty clay that is 40 to 60 percent clay, 20 to 35 percent cobblestones, and 15 to 25 percent pebbles. The substratum is pale brown or light yellowish brown when dry and brown or yellowish brown when moist. It is very cobbly clay loam or very cobbly loam that is 30 to 40 percent cobblestones and 15 to 25 percent pebbles Depth to the calcareous hardpan is 20 to 40 inches.

Gribble cobbly loam, 5 to 20 percent slopes (GrD).—This soil is in irregularly shaped areas on terraces.

Included with this soil in mapping were areas of McMeen and Tub soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit VIe; Shrubby Rolling Hills range site; wildlife group 4.

Hankins Series

The Hankins series consists of well-drained soils that formed on uplands in colluvium mixed with ash in the upper part and clay in the lower part. Slopes are 15 to 50 percent. Elevation is 3,500 to 5,000 feet. The vegetation is ponderosa pine, grasses, forbs, and shrubs. Average annual precipitation is 16 to 25 inches, average annual air temperature is 40 to 45° F., and the frost-free season is 20 to 60 days at 32° and 90 to 100 days at 28°.

In a representative profile the surface layer is gray cobbly loam about 9 inches thick. The upper part of the subsoil is gray cobbly loam about 4 inches thick. The lower part is brown and pale-brown cobbly clay about 32 inches thick. The substratum is weathered tuff. The soil is neutral throughout.

Permeability is slow. Available water holding capacity is 4.5 to 9.0 inches. Water-supplying capacity is 10 to 15 inches. Effective rooting depth is 40 to 60 inches.

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

Representative profile of Hankins cobbly loam, 15 to 50 percent slopes, located on a southeast-facing slope 200 feet west of where the A–Y Road crosses Big Log Creek in NE¼NW¼ sec. 34, T. 11 S., R. 17 E., Jefferson County:

O1—1 inch to 0, partly decomposed needles, twigs, and leaves. 0 to 1 inch thick.

A11—0 to 3 inches, gray (10YR 5/1) cobbly loam, very dark gray (10YR 3/1) moist; weak, fine, granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, irregular pores; 20 percent cobblestones and 5 percent pebbles; neutral; clear, smooth boundary. 1 to 5 inches thick.

A12—3 to 9 inches, gray (10YR 5/1) cobbly loam, very dark gray (10YR 3/1) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many, very fine, tubular pores; 20 percent cobblestones and 5 percent pebbles; neutral; clear, smooth boundary. 4 to 6 inches thick.

B1—9 to 13 inches, gray (10YR 5/1) cobbly clay loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; common fine roots; many, very fine, tubular pores; few thin clay films on peds; 20 percent cobblestones; neutral; clear, smooth boundary. 4 to 6 inches thick.

IIB21t—13 to 22 inches, brown (10YR 5/3) cobbly clay, dark brown (7.5YR 3/2) moist; weak, medium, prismatic structure and moderate, medium, subangualr blocky; very hard, very firm, very sticky and very plastic; few fine and medium roots; common, very fine, tubular pores; common thin clay films; 30 percent cobblestones; neutral; clear, smooth boundary. 6 to 10 inches thick.

IIB22t—22 to 32 inches, brown (7.5YR 5/3) cobbly clay, dark brown (7.5YR 3/3) moist; moderate, medium, subangular blocky structure; very hard, very fine, very sticky and very plastic; few fine and medium roots, common, very fine, tubular pores; common thin and moderately thick clay films; 30 percent cobblestones, neutral; clear, smooth boundary. 8 to 10 inches thick.

IIB31t—32 to 40 inches, brown (10YR 5/3) cobbly clay, dark brown (10YR 4/3) moist; weak, coarse, subangular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine and medium roots; common, very fine, tubular pores; few thin clay films; 30 percent cobblestones; neutral; clear, smooth boundary. 8 to 10 inches thick.

IIB32—40 to 45 inches, pale-brown (10YR 6/3) cobbly clay, dark brown (10YR 4/3) moist; weak, coarse, subangular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few, very fine, tubular pores; 40 percent cobblestones; neutral; clear, smooth boundary. 0 to 13 inches thick

IIIC—45 inches, weathered tuff.

The surface layer is gray, dark gray, or grayish brown when dry and very dark gray or very dark grayish brown when moist. It is cobbly loam or stony loam that is 20 to 40 percent volcanic ash. The lower part of the subsoil is cobbly clay or stony clay that is 45 to 60 percent clay. Content of cobblestones and stones in the profile ranges from 15 to 30 percent, and as much as 5 percent is pebbles. Depth to weathered tuff is 40 to 60 inches.

Hankins cobbly loam, 15 to 50 percent slopes (HaE).—This soil has long, narrow, south-facing slopes.

Included with this soil in mapping were areas of Boardtree and Yawkey soils; red, mulching, clayey soils; shallow, very stony soils; and rock outcrops.

Runoff is medium to rapid, and the hazard of erosion is moderate to high. Capability unit VIIe; Pine-Bunchgrass range site; woodland suitability group 5c; wildlife group 5.

Lamonta Series

The Lamonta series consists of well-drained soils that formed on uplands in colluvium of sedimentary origin. Slopes are 1 to 12 percent. Elevation is 2,200 to 3,300 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, forbs, shrubs, and juniper. Average annual precipitation is 9 to 12 inches, average annual air temperature is 46 to 50° F., and the frost-free season is 50 to 80 days at 32° and 100 to 130 days at 28°.

In a representative profile the surface layer is grayish-brown cobbly loam and cobbly heavy loam about 16 inches thick. The subsoil is brown and pale-brown cobbly clay about 6 inches thick. A very pale brown, cemented hardpan is at a depth of about 22 inches. The soil is neutral throughout.

Permeability is very slow. Available water holding capacity is 2 to 4 inches. Water-supplying capacity is 6 to 8 inches. Effective rooting depth is 20 to 30 inches.

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

Representative profile of Lamonta cobbly loam, 1 to 12 percent slopes, located about 400 feet east of fence corner and 1,240 feet south and 3,750 feet west of the northeast corner of sec. 14, T. 13 S., R. 14 E., Jefferson County:

A11—0 to 5 inches, grayish-brown (10YR 5/2) cobbly loam, very dark grayish brown (10YR 3/2) moist; weak, thin, platy structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many, very fine, irregular pores; 5 percent pebbles and 20 percent cobblestones; neutral; clear, smooth boundary. 5 to 6 inches thick.

A12—5 to 10 inches, grayish-brown (10YR 5/2) cobbly loam, very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many, very fine, tubular pores, 5 percent pebbles and 20 percent cobblestones; neutral; clear, smooth boundary. 4 to 5 inches thick.

A3—10 to 16 inches, grayish-brown (10YR 5/2) cobbly heavy loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; 5 percent pebbles and 25 percent cobblestones; neutral; abrupt, wavy boundary. 5 to 6 inches thick.

IIB2t—16 to 20 inches, brown (10YR 5/3) cobbly clay, dark brown (10YR 3/3) moist; moderate, medium, prismatic structure and moderate, fine or medium, subangular blocky; very hard, very firm, very sticky and very plastic; few very fine roots; many, very fine, tubular pores; thin continuous clay films; 5 percent pebbles and 25 percent cobblestones; neutral; clear, smooth boundary. 4 to 6 inches thick.

IIB3t—20 to 22 inches, pale-brown (10YR 6/3) cobbly clay, brown (10YR 5/3) moist; weak, very fine, subangular blocky structure; hard, firm, very sticky and very plastic; few very fine roots; many, very fine, tubular pores; thin patchy clay films; 5 percent pebbles and 30 percent cobblestones; neutral; abrupt, wavy boundary. 2 to 7 inches thick.

IIICsim—22 inches, very pale brown (10YR 7/2), indurated, silica-cemented hardpan, yellowish brown (10YR 5/4) moist; massive or thick, platy structure; strongly cemented, extremely hard, extremely firm; surface of hardpan is coated with opal.

The surface layer is cobbly loam, loam, or clay loam. The subsoil is brown, light brownish gray, or pale brown when dry and dark brown or brown when moist. It is clay or cobbly clay. The lower part of the subsoil is noncalcareous or slightly calcareous The soil is cobbly throughout. It is 20 to 30 percent cobblestones and as much as 5 percent pebbles, and the percentage of coarse fragments increases as depth increases. Depth to a cemented, calcareous hardpan is 20 to 30 inches.

Lamonta cobbly loam, 1 to 12 percent slopes (LaC).—This soil is in long, broad, irregularly shaped areas.

Included with this soil in mapping were areas of Madras, McCoin, and Era soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe–2; Shrubby Rolling Hills range site; wildlife group 2.

Lickskillet Series

The Lickskillet series consists of well-drained soils that formed on uplands in shallow, stony colluvium that is a mixture of loess, basalt fragments, and residuum weathered from the underlying basalt. Slopes are 15 to 70 percent. Elevation is 1,000 to 3,600 feet. The vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 10 to 12 inches, average annual air temperature is 45 to 52° F., and the frost-free season is 100 to 150 days at 32° and 120 to 170 days at 28°.

In a representative profile the surface layer and upper part of the subsoil are brown very stony loam about 7 inches thick. The lower part of the subsoil is brown very stony clay loam about 6 inches thick. Bedrock is at a depth of 13 inches. The soil is neutral throughout.

Permeability is moderate. Available water holding capacity is 1 to 3 inches. Water-supplying capacity is 2.5 to 5.0 inches. Effective rooting depth is 12 to 20 inches.

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

Representative profile of Lickskillet very stony loam, 15 to 40 percent slopes, located about 70 feet west of the corner of NE¼NE¼NE¼ sec. 33, T. 4 S., R. 14 E., Wasco County:

A1—0 to 3 inches, brown (10YR 5/3) very stony loam, very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; about 40 percent, by volume, basalt fragments, 2 millimeters and coarser in diameter; neutral; clear, wavy boundary. 3 to 6 inches thick.

B1—3 to 7 inches, brown (10YR 5/3) very stony loam, dark brown (7.5YR 3/3) moist; moderate, very fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, tubular pores; about 40 percent, by volume, basalt fragments, 2 millimeters and coarser in diameter; neutral; abrupt, wavy boundary. 4 to 6 inches thick.

B2—7 to 13 inches, brown (7.5YR 4/3) very stony clay loam, dark brown (7.5YR 3/3) moist; weak, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; common fine roots; common, very fine, tubular pores; about 80 percent basalt fragments, coarser than 2 millimeters in diameter; neutral; abrupt, wavy boundary. 5 to 8 inches thick.

IIR—13 inches, fractured basalt bedrock.

The surface layer is grayish brown or brown when dry and very dark grayish brown or dark brown when moist. It is loam, silt loam, or very fine sandy loam that is 10 to 20 percent pebbles and 20 to 40 percent cobblestones and stones. The subsoil is brown or yellowish brown when dry and dark brown or dark yellowish brown when moist. It is heavy loam, clay loam, or silty clay loam that is 10 to 20 percent pebbles and 40 to 65 percent cobblestones and stones. Clay content is 20 to 30 percent. Depth to bedrock is 12 to 20 inches

Lickskillet very stony loam, 15 to 40 percent slopes (LcE).—This soil has convex, south-facing slopes and is in long, narrow areas. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Bakeoven, Condon, and Wrentham soils.

Runoff is rapid, and the hazard of erosion is high. Capability unit VIIs; Droughty South Exposure range site; wildlife group 1.

Lickskillet extremely stony loam, 40 to 70 percent slopes (LeF).—This soil has convex, south-facing slopes and is in long, narrow areas. It has a profile similar to the one described as representative of the series, but it contains more stones.

Included with this soil in mapping were areas of Rock outcrop and Rubble land and Wrentham, Bakeoven, and Condon soils.

Runoff is rapid, and the hazard of erosion is high. Capability unit VIIs; Droughty Steep South range site; wildlife group 1.

Lithgow Series

The Lithgow series consists of well-drained soils that formed on uplands in mixed loess and colluvium and rhyolitic tuff. Slopes are 20 to 50 percent. Elevation is 2,000 to 3,300 feet. The vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 9 to 10 inches, average annual air temperature is 47 to 51° F., and the frost-free season is 80 to 100 days at 32° and 110 to 140 days at 28°.

In a representative profile the surface layer is light brownish-gray gravelly loam about 3 inches thick. The upper part of the subsoil is light brownish-gray gravelly clay loam about 14 inches thick. The lower part is light brownish-gray very gravelly clay loam about 5 inches thick. Rhyolitic tuff is at a depth of about 22 inches. The soil is neutral throughout.

Permeability is moderately slow. Available water holding capacity is 2 to 7 inches. Water-supplying capacity is 5 to 7 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for range and wildlife habitat.

Representative profile of a Lithgow soil in an area of Lithgow and Sorf soils, 20 to 50 percent slopes, located 300 feet north of road in SW¼SE¼SE¼ sec. 33, T. 8 S., R. 18 E., Wasco County:

A1—0 to 3 inches, light brownish-gray (10YR 6/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure and weak, thin, platy; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, irregular pores; 30 percent pebbles; neutral; clear, wavy boundary. 1 to 5 inches thick.

B1—3 to 8 inches, light brownish-gray (10YR 6/2) gravelly clay loam, dark grayish brown (10YR 4/2) moist; moderate, fine, granular structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; 25 percent pebbles; neutral; abrupt, wavy boundary. 0 to 8 inches thick.

B21t—8 to 17 inches, light brownish-gray (10YR 6/2) gravelly clay loam, dark grayish brown (10YR 4/2) moist; weak, medium, subangular blocky structure, hard, firm, sticky and plastic; few very fine roots; many, very fine, tubular pores; few thin clay films on peds; 40 percent pebbles, 2 to 10 millimeters in diameter; neutral; clear, wavy boundary. 6 to 15 inches thick.

B22t—17 to 22 inches, light brownish-gray (10YR 6/2) very gravelly clay loam, dark grayish brown (10YR 4/2) moist; weak, fine and medium, subangular blocky structure; hard, firm, sticky and plastic; very few very fine roots; many, very fine, tubular pores; common thin clay films in pores and few thin films on surfaces of peds; 50 percent pebbles, 2 millimeters

to 1½ inches in diameter; neutral; abrupt, wavy boundary. 4 to 15 inches thick.

IIR—22 inches, rhyolitic tuff.

The surface layer is light brownish gray or pale brown when dry and very dark grayish brown or dark brown when moist. It is loam to light clay loam that is 20 to 30 percent pebbles. The subsoil is light brownish gray or light gray when dry and dark grayish brown or brown when moist. It is gravelly or very gravelly clay loam that is 30 to 35 percent clay and 35 to 60 percent pebbles. Depth to underlying tuff is 20 to 40 inches.

Lithgow and Sorf soils, 20 to 50 percent slopes (LgE).—This undifferentiated group consists of about 60 percent Lithgow soils and 25 percent Sorf soils. These soils have south-facing slopes and are in irregularly shaped areas. A Lithgow soil in this mapping unit has the profile described as representative of the series. A Sorf soil in this mapping unit has a profile similar to the one described as representative of the Sorf series, but the surface layer contains about 25 percent cobblestones and very few stones.

Included with this group in mapping were areas of shallow very stony soils, moderately deep and deep silt loams, Simas soils, and Rock outcrop and Rubble land that make up as much as 15 percent of this mapping unit.

Runoff is medium, and the hazard of erosion is high. Capability unit VIe; Droughty South Exposure range site; wildlife group 4.

Lithgow Series, Deep Variant

The Lithgow series, deep variant, consists of somewhat excessively drained soils that formed on uplands in wind-laid silt and fractured shale. Slopes are 50 to 70 percent. Elevation is 2,000 to 3,300 feet. The vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 9 to 10 inches, average annual air temperature is 47 to 51° F., and the frost-free season is 80 to 110 days at 32° and 110 to 140 days at 28°.

In a representative profile the surface layer is brown and pale-brown very shaly loam about 13 inches thick. The underlying material is light yellowish-brown and very pale brown very shaly loam about 47 inches thick. The soil is neutral to a depth of 13 inches, mildly alkaline between depths of 13 and 33 inches, and moderately alkaline below a depth of 33 inches.

Permeability is moderately rapid. Available water holding capacity is 3 to 6 inches. Water-supplying capacity is 4 to 5 inches. Effective rooting depth is 40 inches to more than 60 inches.

These soils are used for range and wildlife habitat.

Representative profile of Lithgow very shaly loam, deep variant, 50 to 70 percent slopes, located 300 feet north of road and one-fourth mile west of Muddy Creek ranch headquarters in NE¼SW¼NE¼ sec. 31, T. 8 S., R. 19 E., Wasco County:

A1—0 to 5 inches, brown (10YR 5/3) very shaly loam, dark brown (10YR 4/3) moist; weak, very fine, granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many, very fine, irregular pores; 25 percent pebbles, 2 millimeters to 2 inches in diameter; neutral; clear, wavy boundary. 4 to 6 inches thick.

AC—5 to 13 inches, pale-brown (10YR 6/3) very shaly loam, dark yellowish brown (10YR 4/4) moist; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; 50 percent pebbles, 2 millimeters to 2 inches in diameter; neutral; clear, wavy boundary. 8 to 10 inches thick.

C1—13 to 23 inches, light yellowish-brown (10YR 6/4) very shaly loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; many, very fine, tubular pores; 65 percent pebbles, 2 millimeters to 2 inches in diameter; mildly alkaline; gradual, wavy boundary. 10 to 15 inches thick.

C2—23 to 33 inches, very pale brown (10YR 7/4) very shaly loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; many, very fine, tubular pores; 65 percent pebbles, 2 millimeters to 2 inches in diameter; mildly alkaline; gradual, wavy boundary. 10 to 15 inches thick.

C3—33 to 60 inches, very pale brown (10YR 7/4) very shaly loam, light yellowish brown (10YR 6/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; very few fine roots; common, very fine, tubular pores; 70 percent pebbles, 2 millimeters to 2 inches in diameter; weakly calcareous; moderately alkaline. 8 to 14 inches thick.

The surface layer is brown or pale brown when dry and dark brown or grayish brown when moist. The substratum is very pale brown, pale brown, or light yellowish brown when dry and dark yellowish brown, yellowish brown, or light yellowish brown when moist. The profile is 25 to 70 percent pebbles that are 2 millimeters to 3 inches in diameter. Depth to fractured shale is 40 inches to more than 60 inches.

Lithgow very shaly loam, deep variant, 50 to 70 percent slopes (LhF).—This soil has convex, south-facing slopes and is in long, narrow areas.

Included with this soil in mapping were areas of Lithgow and Simas soils and shallow, shaly or stony, medium-textured and moderately fine textured soils.

Runoff is rapid, and the hazard of erosion is high. Capability unit VIIs; Droughty Steep South range site; wildlife group 4.

Madras Series

The Madras series consists of well-drained soils that formed on upland plateaus and terraces in moderately deep, medium-textured and moderately fine textured colluvium. Slopes are 1 to 40 percent. Elevation is 2,200 to 3,200 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, forbs, shrubs, and juniper. Average annual precipitation is 9 to 11 inches, average annual air temperature is 46 to 50° F., and the frost-free season is 50 to 80 days at 32° and 100 to 130 days at 28°.

In a representative profile the surface layer is light brownish-gray loam about 13 inches thick. The upper part of the subsoil is light brownish-gray light clay loam about 5 inches thick. The lower part is pale-brown gravelly light clay loam about 5 inches thick. It is underlain by a strongly calcareous, fractured pan. An indurated, calcareous hardpan is at a depth of about 29 inches. The soil is neutral to a depth of 18 inches and mildly alkaline between depths of 18 to 23 inches.

Permeability is moderate. Available water holding capacity is 3 to 6 inches. Water-supplying capacity is 5 to 7 inches. Effective rooting depth is 20 to 30 inches.

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

Representative profile of Madras loam, 1 to 12 percent slopes, located 50 feet south of fence and 210 feet west of road in NW¼NW¼ sec. 10, T. 11 S., R. 14 E., Jefferson County:

A1—0 to 4 inches, light brownish-gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak, thin, platy structure and weak, fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, irregular pores; neutral; 25 percent pumice sand; abrupt, smooth boundary. 4 to 6 inches thick.

A3—4 to 13 inches, light brownish-gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common, very fine, tubular pores; 25 percent pumice sand; neutral; clear, smooth boundary. 6 to 9 inches thick.

B21—13 to 18 inches, light brownish-gray (10YR 6/2) light clay loam, dark brown (10YR 3/3) moist; 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. 5 to 7 inches thick.

IIB22tca—18 to 23 inches, pale-brown (10YR 6/3) gravelly clay loam, dark brown (10YR 4/3) moist; weak, medium, prismatic structure and moderate, fine, subangular blocky; hard, friable, sticky and plastic; few very fine roots; many, very fine, tubular pores; thin patchy clay films on peds; strongly calcareous; 20 percent pebbles and 5 percent cobblestones; mildly alkaline; clear, smooth boundary. 5 to 6 inches thick.

IIIC1sim—23 to 29 inches, white (10YR 8/1) fractured pan, very pale brown (10YR 7/3) moist; strongly calcareous 0 to 6 inches thick.

IIIC2sim—29 inches, indurated calcareous hardpan.

The surface layer is light brownish gray or pale brown when dry and very dark grayish brown, dark brown, or brown when moist. The surface layer is 0 to 20 percent pebbles. The subsoil is grayish brown, light brownish gray, or pale brown when dry and dark brown or dark grayish brown when moist. It is heavy loam to clay loam that is 0 to 20 percent cobblestones Structure in the subsoil ranges from weak, medium, prismatic to weak or moderate, subangular blocky. The subsoil is 20 to 30 percent clay. Depth to the indurated hardpan is 20 to 30 inches.

Madras loam, 1 to 12 percent slopes (MaC).—This soil is in irregularly shaped areas. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Agency, Era, and Metolius soils.

Runoff is slow to medium, and the hazard of erosion is slight to moderate. Capability unit IVe–2; Arid Rolling Hills range site; wildlife group 2.

Madras soils, 12 to 40 percent slopes (MbE).—This undifferentiated group consists of about 40 percent Madras cobbly loam and about 45 percent one or more soils that are mostly shallow, very cobbly or stony, and loamy or clayey. Individual areas can include any combination of these kinds of soil, none of which makes up as much as 15 percent of the total area of the mapping unit. The Madras soil has a profile similar to the one described as representative of the series, but in some places the surface layer is as much as 30 percent pebbles and cobblestones.

Included with this undifferentiated group in mapping were areas of Agency, Era, Lamonta, and McCoin soils that make up as much as 15 percent of this mapping unit.

Runoff is medium, and the hazard of erosion is moderate. Capability unit VIIs; Droughty South Exposure range site; wildlife group 2.

McCoin Series

The McCoin series consists of well-drained soils that formed on upland plains in medium-textured to moderately fine textured colluvium. Slopes are 5 to 20 percent. Elevation is 3,200 to 3,400 feet. Where this soil is not cultivated, the vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 9 to 12 inches, average annual air temperature is 46 to 47° F., and the frost-free season is 50 to 80 days at 32° and 100 to 130 days at 28°.

In a representative profile the surface layer is grayish-brown loam about 9 inches thick. The upper part of the subsoil is brown heavy loam about 4 inches thick. The lower part is brown clay loam about 3 inches thick. Tuffaceous sandstone is at a depth of 16 inches. The soil is neutral throughout.

Permeability is moderate. Available water holding capacity is 1.5 to 3.5 inches. Water-supplying capacity is 5 to 7 inches. Effective rooting depth is 10 to 20 inches.

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

Representative profile of McCoin loam, 5 to 20 percent slopes, located about 300 feet east of road and 300 feet south of road in SE¼SW¼SW¼ sec. 5, T. 13 S., R. 14 E., Jefferson County:

A11—0 to 2 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 5 percent pebbles and 5 percent cobblestones; neutral; clear, smooth boundary. 2 to 6 inches thick.

A12—2 to 9 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; 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 and 5 percent cobblestones; neutral; clear, smooth boundary. 2 to 8 inches thick.

B21—9 to 13 inches, brown (10YR 5/3) heavy loam, dark brown (10YR 3/3) moist; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; many, very fine, tubular pores; 5 percent pebbles and 5 percent cobblestones; neutral; abrupt, smooth boundary. 3 to 6 inches thick.

B22—13 to 16 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; few, very fine, tubular pores; 5 percent pebbles and 5 percent cobblestones; neutral; abrupt, irregular boundary. 3 to 8 inches thick.

IIC—16 inches, light yellowish-brown (10YR 6/4) tuffaceous sandstone, brown (10YR 4/3) moist; difficult to chip with a spade; thin lime coating on surface.

The surface layer is dark grayish brown or grayish brown when dry. The subsoil is brown, yellowish brown, or pale brown when dry and dark brown or brown when moist. It is clay loam or heavy loam that is 22 to 30 percent clay. Its structure is weak or moderate, subangular blocky. The solum is 5 to 10 percent pebbles and 5 to 10 percent cobblestones. Depth to tuffaceous sandstone is 10 to 20 inches.

McCoin loam, 5 to 20 percent slopes (McD).—This soil is in irregularly shaped areas in the Lone Pine area.

Included with this soil in mapping were areas of Madras, Lamonta, and Era soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IVe–2; Shrubby Rolling Hills range site; wildlife group 2.

McMeen Series

The McMeen series consists of well-drained soils that formed on upland plains in loess and colluvium. Slopes are 1 to 12 percent. Elevation is 2,700 to 3,500 feet. Where this soil is not cultivated, the vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 11 to 14 inches, average annual air temperature is 45 to 48° F., and the frost-free season is 50 to 70 days at 32° and 90 to 130 days at 28°.

In a representative profile the upper part of the surface layer is gray silt loam about 8 inches thick. The lower part is grayish-brown silty clay loam about 6 inches thick. The subsoil is grayish-brown silty clay loam about 13 inches thick. A hardpan is at a depth of 27 inches. The soil is neutral to a depth of 14 inches and mildly alkaline between depths of 14 and 27 inches.

Permeability is moderately slow. Available water holding capacity is 4 to 9 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, pasture, range, wildlife habitat, and water supply.

Representative profile of McMeen silt loam, 1 to 12 percent slopes, located about 100 feet south of Tub Springs Road in NW¼SW¼NW¼ sec. 36, T. 8 S., R. 16 E., Wasco County:

Ap—0 to 8 inches, gray (10YR 5/1) silt loam, black (10YR 2/1) moist; moderate, very fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 2 percent cobblestones and 5 percent pebbles; neutral; abrupt, smooth boundary. 6 to 9 inches thick.

A3—8 to 14 inches, grayish-brown (10YR 5/2) silty clay loam, very dark brown (10YR 2/2) moist; weak, fine, subangular blocky structure and weak, very fine, granular; hard, friable, sticky and plastic; many very fine roots; many, very fine, tubular pores; 2 percent cobblestones and 5 percent pebbles; neutral; gradual, wavy boundary. 0 to 10 inches thick.

B2—14 to 27 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; many very fine roots; many, very fine, tubular pores; 10 percent pebbles and 5 percent cobblestones; few ½-inch, firm, strongly calcareous nodules; mildly alkaline; abrupt, smooth boundary. 10 to 22 inches thick.

IICsim—27 inches, white (10YR 8/1) cobbly hardpan, pale brown (10YR 6/3) moist; massive; weakly cemented; very hard, very firm; discontinuous coatings of opal in upper part of horizon; 25 percent cobblestones and 5 percent pebbles; strongly calcareous.

The surface layer is dark grayish brown, grayish brown, or gray when dry and black, very dark brown, or very dark grayish brown when moist. It is silt loam, silty clay loam, or loam that has weak or moderate, granular and very fine and fine, subangular blocky structure. The subsoil is grayish brown, brown, or pale brown when dry and very dark grayish brown or brown when moist. It is clay loam or silty clay loam that is 27 to 35 percent clay and more than 15 percent sand that is coarser than very fine sand. Structure is weak, medium, subangular blocky to granular. The solum down to the cobbly hardpan is 5 to 10 percent pebbles and as much as 5 percent cobblestones. Depth to the cobbly, calcareous hardpan is 20 to 40 inches.

McMeen silt loam, 1 to 12 percent slopes (MmC).—This soil is in irregularly shaped areas on broad ridgetops.

Included with this soil in mapping were areas of Tub, Curant, Era, and Gribble soils.

Runoff is medium, and the hazard of erosion is moderate. Capability unit IIIe–1; Droughty Rolling Hills range site; wildlife group 4.

Metolius Series

The Metolius series consists of well-drained soils that formed on bottom lands and alluvial fans in alluvium that contains a large amount of pumice sand. Slopes are 0 to 8 percent. Elevation is 2,000 to 3,000 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 9 to 12 inches, average annual air temperature is 47 to 50° F., and the frost-free season is 50 to 80 days at 32° and 100 to 130 days at 28°.

In a representative profile the surface layer is grayish-brown sandy loam about 6 inches thick. The subsoil is light brownish-gray and pale-brown sandy loam about 22 inches thick. The upper part of the substratum is pale-brown loam about 21 inches thick. The lower part is very pale brown gravelly loam about 11 inches thick. The soil is neutral to a depth of 49 inches and moderately alkaline between depths of 49 and 60 inches.

Permeability is moderately rapid. Available water holding capacity is 7 to 13 inches. Water-supplying capacity is approximately 6 inches. Effective rooting depth is 40 inches to more than 60 inches.

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

Representative profile of Metolius sandy loam, 0 to 8 percent slopes, located about 200 feet south of road in NE¼NW¼ sec. 3, T. 11 S., R. 14 E., Jefferson County:

A1—0 to 6 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak, thin, platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, tubular pores; 20 percent pumice sand; neutral; clear, smooth boundary. 4 to 6 inches thick.

B1—6 to 14 inches, light brownish-gray (10YR 6/2) sandy loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; 30 percent pumice sand; few hard nodules; neutral; gradual, smooth boundary. 0 to 12 inches thick.

B2—14 to 28 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 4/3) moist; weak, coarse, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; few hard nodules, 1 to 3 centimeters in diameter; 40 percent pumice sand; neutral; gradual, smooth boundary. 8 to 20 inches thick.

C1si—28 to 49 inches, pale-brown (10YR 6/3) loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, irregular pores; 45 percent pumice sand; 3 percent pebbles; many, hard, calcareous nodules, 1 to 3 centimeters in diameter; pebbles are lime coated; neutral; wavy, irregular boundary. 20 to 30 inches thick.

IIC2sica—49 to 60 inches, very pale brown (10YR 7/3) gravelly loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many, very fine, irregular pores; 20 percent pebbles; many, firm, pale-brown (10YR 6/3) and brown (10YR 5/3), calcareous durinodes and myceliumlike lime veins; lime pendants occur on gravel; strongly calcareous; moderately alkaline.

The surface layer is grayish brown or light brownish gray when dry and very dark grayish brown, dark brown, or dark grayish brown when moist. The content of pumice sand is 10 to 25 percent. The subsoil is light brownish gray, pale brown, or very pale brown when dry and dark grayish brown, dark brown, or brown when moist. It is sandy loam, fine sandy loam, or light loam and is 30 to 60 percent pumice sand. The substratum is very pale brown, pale brown, gray, or light gray when dry and dark grayish brown, brown, or grayish brown when moist. It is sandy loam, gravelly loam, or loam that is weakly calcareous to strongly calcareous. The content of pumice sand is 35 to 60 percent, and the content of pebbles is 5 to 20 percent. Depth to bedrock is 40 inches to more than 60 inches.

Metolius sandy loam, 0 to 8 percent slopes (MtB).—This soil is in long, narrow areas on bottom lands.

Included with this soil in mapping were areas of Court, Era, Madras, and Agency soils.

Runoff is slow, and hazard of erosion is slight. Some areas are subject to occasional flooding. Capability unit IVe–1; Droughty Bottomland Fan range site; wildlife group 3.

Mixed Alluvial Land

Mixed alluvial land (Mx) consists of mixed clay loam, silty clay loam, loam, and sandy loam alluvial materials. These materials commonly are dark colored throughout. Water-rounded pebbles or cobblestones commonly form thin stone lines or layers at various depths from the surface.

This land type is in small, narrow, irregular areas along major streams and on alluvial fans. It is generally well drained, but in some areas at higher elevations there is a seasonal high water table.

This land type has slopes of 0 to 2 percent. Elevation is 1,400 to 4,500 feet. Where this land type is not cultivated, the vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 9 to 25 inches, average annual air temperature is 40° to 51° F., and the frost-free season is 30 to 120 days at 32° and 80 to 150 days at 28°.

Permeability is moderately rapid to slow. Available water holding capacity and water-supplying capacity are variable. Effective rooting depth is 20 inches to more than 60 inches. Reaction is slightly acid to moderately alkaline. Runoff is slow, and the hazard of erosion is slight. This land is subject to flooding, and in places stream erosion is severe.

Included with this land type in mapping were areas of Rail and Willowdale soils.

Mixed alluvial land is used for irrigated hay, pasture, range, wildlife habitat, and water supply. Capability unit IIIw–1; Semi-wet Bottom range site; wildlife group 3.

Playas

Playas (Pa) consists of somewhat poorly drained soils that formed in alluvium in closed basins. This land type is in irregular tracts in an area that was under water as recently as 75 years ago. The surface layer is gray or light gray when dry and is silt loam, silty clay loam, or silty clay. The underlying material is pale brown, very pale brown, light brownish gray, or gray when dry and is silt loam, silty clay cloam, silty clay, or clay. Free lime is at a depth below 30 inches in some areas. In summer as this land type dries, it shrinks and forms deep, wide cracks.

This land type has slopes of 0 to 1 percent. Elevation is 2,400 to 2,600 feet. Where this land type is not cultivated, there is no vegetation. Average annual precipitation is 10 to 13 inches, average annual air temperature is 45° to 52° F., and the frost-free season is 100 to 150 days at 32° and 120 to 170 days at 28°.

Permeability is slow. Available water holding capacity is 8 to 12 inches. Water-supplying capacity is 6 to 9 inches. Effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of erosion is slight.

Playas are used for dryfarmed small grain, pasture, range, and wildlife habitat. Capability unit IVw–1; not placed in a range site; wildlife group 1.

Prag Series

The Prag series consists of well-drained soils that formed on uplands in rhyolitic colluvium. Slopes are 5 to 50 percent. Elevation is 3,500 to 4,500 feet. The vegetation is bunchgrasses, forbs, shrubs, and juniper trees. Average annual precipitation is 13 to 16 inches, average annual air temperature is 42 to 45° F., and the frost-free season is 30 to 60 days at 32° and 90 to 110 days at 28°.

In a representative profile the surface layer is dark-gray cobbly loam about 9 inches thick. The subsoil is dark grayish-brown and brown cobbly clay about 26 inches thick. The substratum is brown very cobbly clay about 5 inches thick. Partially consolidated tuff sediment is at a depth of about 40 inches. The soil is neutral to a depth of 14 inches, mildly alkaline between depths of 14 and 22 inches, and moderately alkaline between depths of 22 and 40 inches.

Permeability is slow. Available water holding capacity is 3 to 6 inches. Water-supplying capacity is 6 to 9 inches. Effective rooting depth is 20 to 40 inches.

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

Representative profile of Prag cobbly loam, 5 to 40 percent slopes, located 50 feet east of dirt road in NW¼SE¼NE¼ sec. 3, T. 11 S., R. 16 E., Jefferson County:

A11—0 to 3 inches, dark-gray (10YR 4/1) cobbly loam, black (10YR 2/1) moist; weak, thin, platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 10 percent pebbles and 15 percent cobblestones; neutral; clear, smooth boundary, 3 to 6 inches thick.

A12—3 to 9 inches, dark-gray (10YR 4/1) cobbly loam, black (10YR 2/1) moist; weak to moderate, fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, tubular pores; 10 percent pebbles and 15 percent cobblestones; neutral; abrupt, smooth boundary. 3 to 6 inches thick.

IIB21t—9 to 14 inches, dark grayish-brown (10YR 4/2) cobbly clay, very dark grayish brown (10YR 3/2) moist; moderate, coarse, prismatic structure and strong, medium, subangular blocky; very hard, very firm, very sticky and very plastic; few very fine roots; common, very fine, tubular pores; thick, nearly continuous, very dark brown (10YR 2/2) coatings on faces of peds; 10 percent pebbles, 20 percent cobblestones, and 5 percent stones; neutral; clear, smooth boundary. 5 to 8 inches thick.

IIB22t—14 to 22 inches, brown (10YR 5/3) cobbly clay, dark brown (10YR 3/3) moist; very dark brown (10YR 2/2) coatings on faces of peds; moderate, coarse, prismatic structure and strong, medium, subangular blocky; very hard, very firm, very sticky and very plastic; few very fine roots; few, very fine, tubular pores; thick, nearly continuous, very dark brown (10YR 2/2) coatings on faces of peds; 20 percent cobblestones, 5 percent pebbles, and 5 percent stones; mildly alkaline; clear, smooth boundary. 6 to 10 inches thick.

IIB3t—22 to 35 inches, brown (10YR 5/3) cobbly clay, dark brown (10YR 4/3) moist; weak, medium, subangular blocky structure; very hard, firm, very sticky and very plastic; few very fine roots; few, very fine, tubular pores; thin nearly continuous coatings; 20 percent cobblestones, 10 percent pebbles, and 5 percent stones that have coatings of lime; common light-gray lime segregations; moderately alkaline; abrupt, wavy, boundary. 3 to 15 inches thick.

IIC1ca—35 to 40 inches, brown (10YR 5/3) very cobbly clay, dark brown (10YR 4/3) moist; massive; very hard, firm, very sticky and very plastic; 50 percent cobblestones; common light-gray lime segregations; moderately alkaline; abrupt, wavy boundary. 0 to 8 inches thick.

IIIC2—40 inches, weathered tuff.

The surface layer is dark gray, dark grayish brown, or grayish brown when dry and black or very dark brown when moist. It is cobbly loam, silt loam, or cobbly silt loam that is 10 to 15 percent cobblestones and 5 to 10 percent pebbles The subsoil is dark grayish brown, grayish brown, or brown when dry and very dark grayish brown, dark brown, or dark yellowish brown when moist. It is clay or cobbly clay that is 0 to 5 percent stones, 15 to 20 percent cobblestones, and 5 to 10 percent pebbles. Depth to weathered tuff is 20 to 40 inches.

Prag cobbly loam, 5 to 40 percent slopes (PrE).—This soil has north-facing slopes and is in long, narrow, irregularly shaped areas. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Ginser and Tub soils.

Runoff is medium, and hazard of erosion is moderate. Capability unit VIe; North Exposure range site; wildlife group 4.

Prag very stony loam, 12 to 50 percent slopes (PvE).—This soil has south-facing slopes and is in long, narrow, irregularly shaped areas.

Included with this soil in mapping were areas of Hankins, Boardtree, and Yawkey soils.

Runoff is medium to rapid, and the hazard of erosion is moderate. Capability unit VIIs; South Exposure range site; wildlife group 4.

Rail Series

The Rail series consists of somewhat poorly drained soils that formed on alluvial terraces in fine-textured, mixed alluvium. Slopes are 0 to 2 percent. Elevation is 1,700 to 3,000 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 10 to 14 inches, average annual air temperature is 46 to 50° F., and the frost-free season is 50 to 70 days at 32° and 90 to 130 days at 28°.

In a representative profile the soil is dark-gray clay about 60 inches thick or more. It is neutral to a depth of 2 inches, mildly alkaline between depths of 2 and 16 inches, and moderately alkaline between depths of 16 and 60 inches.

Permeability is very slow. Available water holding capacity is 6 to 10 inches. Water-supplying capacity is 6.5 to 9.0 inches. Effective rooting depth is 40 inches to more than 60 inches.

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

Representative profile of Rail clay, located about 800 feet west of highway bridge over Cold Camp Creek in NE¼NW¼ sec. 24, T. 8 S., R. 16 E., Wasco County:

A11—0 to 2 inches, dark-gray (10YR 4/1) clay, black (10YR 2/1) moist; strong, fine, granular structure; very hard, firm, very sticky and very plastic; many very fine roots; many, very fine, irregular pores; neutral; abrupt, wavy boundary. 1 to 4 inches thick.

A12—2 to 8 inches, dark-gray (10YR 4/1) clay, black (10YR 2/1) moist; moderate, coarse, prismatic structure and moderate, medium, subangular blocky; very hard, very firm, very sticky and very plastic; common very fine roots; many, very fine, tubular pores; mildly alkaline; gradual, smooth boundary. 6 to 12 inches thick.

A13—8 to 16 inches, dark-gray (10YR 4/1) clay, black (10YR 2/1) moist; moderate, coarse, prismatic structure and weak, medium, angular blocky; very hard, very firm, very sticky and very plastic; common very fine roots; many, very fine, tubular pores; mildly alkaline; gradual, smooth boundary. 6 to 12 inches thick.

AC1cag—16 to 25 inches, dark-gray (10YR 4/1) clay, black (10YR 2/1) moist; many, distinct, strong-brown (7.5YR 4/6) mottles, mainly along root channels; weak, coarse, prismatic structure and strong, fine and medium, angular blocky; very hard, very firm, very sticky and very plastic; common very fine roots; common, very fine, tubular pores; moderately alkaline; strongly calcareous and has few lime seams; gradual, smooth boundary. 8 to 15 inches thick.

AC2cag—25 to 32 inches, dark-gray (10YR 4/1) clay, black (10YR 2/1) moist; common, distinct, strong-brown (7.5YR 4/6) mottles, mainly along root channels; weak, coarse, prismatic structure and moderate, coarse, angular blocky; very hard, very firm, very sticky and very plastic; few very fine roots; common, very fine, tubular pores; strongly calcareous; moderately alkaline; gradual, smooth boundary. 0 to 10 inches thick.

AC3cag—32 to 60 inches, dark-gray (10YR 4/1) clay, black (N 2/0) moist; many, distinct, strong-brown (7.5YR 4/6) stains along root channels; weak, coarse, prismatic structure and moderate, medium, angular blocky; very hard, very firm, very sticky and very plastic; few fine roots; many pressure faces and few slickensides; strongly calcareous and has lime seams; moderately alkaline.

The surface layer and underlying material are very dark gray or dark gray when dry and black or very dark gray when moist. Texture throughout the profile is clay to silty clay. Lenses of sand, gravel, or cobblestones are at a depth below 40 inches in places. The soil is calcareous at a depth below 20 inches. Depth to underlying gravel or cobblestones is 40 inches to more than 60 inches.

Rail clay (Ra).—This soil is in long, narrow, irregularly shaped areas.

Included with this soil in mapping were areas of Willowdale soils and strongly alkaline soils.

Runoff is slow, and the hazard of erosion is slight. Some areas are subject to occasional flooding. Capability unit IVw–1; Moist Alkaline Bottom range site; wildlife group 3.

Riverwash

Riverwash (Rh) consists of excessively drained, coarse-textured alluvium in narrow, irregularly shaped areas in the bends of stream channels and along intermittent drainageways. The soil areas are 2 to 10 feet above the normal waterline and are 40 to 200 yards in width. They consist of sand and well-rounded gravel, stones, and boulders, chiefly composed of rhyolite, andesite, or basalt.

The surface of the landscape is generally uneven. Elevation is 1,400 to 3,000 feet. The vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 9 to 12 inches, average annual air temperature is 47° to 51° F., and the frost-free season is 60 to 120 days at 32° and 90 to 150 days at 28°.

Permeability is very rapid. Effective rooting depth is less than 20 inches to more than 40 inches. The hazard of erosion is high. This land is subject to flooding when the water is high and is extremely droughty when the water is low. During each flood, new deposits are received or some material is removed.

Included with this land type in mapping were adjacent river sandbars.

Riverwash is used for range and wildlife habitat. Capability unit VIIIw; not placed in a range site; wildlife group 3.

Rock Outcrop-Rubble Land Complex

The Rock outcrop-Rubble land complex (Rr) consists of a mixture of about 65 to 75 percent rock outcrop and 20 to 30 percent rubble land. This land type formed on uplands in basalt outcrop and rubble.

Elevation is 1,700 to 4,500 feet. Average annual precipitation is 9 to 16 inches, average annual air temperature is 42° to 51° F., and the frost-free season is 30 to 100 days at 32° and 60 to 170 days at 28°.

This complex is limited by very steep, rocky slopes; steep, severely eroded slopes; and basalt cliffs that have rocky foot slopes. The nearly perpendicular cliffs are as much as 500 feet high.

Included with this complex in mapping were areas of Lickskillet and Wrentham soils that make up as much as 15 percent of the acreage. Small areas of this complex were included in most of the mapping units in the survey area.

Rock outcrop-Rubble land complex is used mainly for wildlife habitat and water supply. It has limited use as range. Capability unit VIIIs; not placed in a range site; wildlife group 1.

Rough Broken and Stony Land

Rough broken and stony land (Ru) (fig. 8) consists of well-drained soil material that formed in basalt colluvium and sediment on uplands. This land type is in long, narrow areas on north- and south-facing slopes of ridges that are broken by numerous intermittent drainageways. It includes areas that have enough stones, boulders, and rock outcrops to prevent tillage and reseeding and to limit grazing by livestock.

Figure 8.—Area of Rough broken and stony land.

Slopes are 20 to 70 percent. Elevation is 1,700 to 4,500 feet. The vegetation is bunchgrasses, forbs, shrubs, and juniper trees. Average annual precipitation is 9 to 16 inches, average annual air temperature is 42° to 51° F., and the frost-free season is 30 to 110 days at 32° and 60 to 170 days at 28°. Effective rooting depth is less than 20 to 60 inches.

Included with this land type in mapping were areas of Simas, Tub, Wrentham, Lickskillet, Prag, and Ginser soils. Small areas of this land type were included in most of the mapping units in the survey area.

Rough broken and stony land is used for wildlife habitat, range, and water supply. Capability unit VIIs; not placed in a range site; wildlife group 4.

Searles Series

The Searles series consists of well-drained soils that formed on uplands in fine-textured colluvium. Slopes are 35 to 65 percent. Elevation is 3,000 to 4,000 feet. The vegetation is bunchgrass, forbs, shrubs, and juniper trees. Average annual precipitation is 9 to 12 inches, average annual air temperature is 45 to 49° F., and the frost-free season is 60 to 80 days at 32° and 100 to 130 days at 28°.

In a representative profile the surface layer is grayish-brown very stony loam and very gravelly loam about 13 inches thick. The subsoil is brown very gravelly clay loam about 18 inches thick. Fractured rhyolitic bedrock is at a depth of about 31 inches. The soil is neutral throughout.

Permeability is moderate. Available water holding capacity is 2 to 6 inches. Water-suppling capacity is 5 to 7 inches. Effective rooting depth is 20 to 40 inches.

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

Representative profile of Searles very stony loam, 35 to 65 percent slopes, located about 20 feet west of road in NW¼NE¼NW¼ sec. 31, T. 13 S., R. 14 E., Jefferson County:

A1—0 to 6 inches, grayish-brown (10YR 5/2) very stony loam, very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 25 percent pebbles, 5 percent stones, and 5 percent cobblestones; about 15 percent of surface area is covered by stones and cobblestsones; neutral; clear, smooth boundary. 2 to 8 inches thick.

A3—6 to 13 inches, grayish-brown (10YR 5/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate, very fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 30 percent pebbles, 15 percent cobblestones, and 5 percent stones; neutral; clear, irregular boundary. 0 to 8 inches thick.

B21t—13 to 21 inches, brown (10YR 4/3) very gravelly clay loam, dark brown (10YR 3/3) moist; weak, very fine, subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine roots; many, very fine, tubular pores; few clay bridges; 45 percent pebbles and 10 percent cobblestones; neutral; gradual, smooth boundary. 6 to 12 inches thick.

B22t—21 to 31 inches, brown (10YR 4/3) very gravelly clay loam, dark brown (10YR 3/3) moist; moderate, very fine, subangular blocky structure; hard, friable, sticky and plastic; common, very fine, tubular pores and few, fine, tubular pores; few thin clay films on surfaces of peds and in pores; 65 percent pebbles and 5 percent cobblestones; neutral; abrupt, irregular boundary. 6 to 13 inches thick.

IIR—31 inches, fractured rhyolitic bedrock.

The surface layer is grayish brown or brown when dry and very dark brown, very dark grayish brown, or dark brown when moist It is very stony loam, very cobbly loam, gravelly loam, or gravelly sandy loam that is 10 to 20 percent cobblestones and stones and 10 to 30 percent pebbles. The subsoil is brown or pale brown when dry and brown or brown when moist. It is very gravelly heavy loam, very gravelly clay loam, or very gravelly silty clay loam that is 25 to 35 percent clay, 45 to 65 percent pebbles, and 5 to 10 percent cobblestones. Depth to rhyolitic bedrock is 20 to 40 inches.

Searles very stony loam, 35 to 65 percent slopes (SeF).—This soil has south-facing slopes and is in irregularly shaped areas.

Included with this soil in mapping were areas of Simas soils; shallow, very stony soils; and stony loams.

Runoff is rapid, and the hazard of erosion is high. Capability unit VIIs; Juniper South Exposure range site; wildlife group 4.

Simas Series

The Simas series consists of well-drained soils that formed on uplands in loess and colluvium weathered from tuff. Slopes are 8 to 70 percent. Elevation is 1,300 to 3,000 feet. The vegetation is bunchgrasses, forbs, shrubs, and juniper trees. Average annual precipitation is 9 to 12 inches, average annual air temperature is 46 to 50° F., and the frost-free season is 60 to 120 days at 32° and 120 to 150 days at 28°.

In a representative profile the surface layer is grayish-brown cobbly silty clay loam about 5 inches thick. The subsoil is brown and very pale brown silty clay about 18 inches thick. The upper part of the substratum is white silt loam about 4 inches thick. The lower part of the substratum is pale brown to very pale brown loam. Calcareous weathered tuff is at a depth of 27 inches. The soil is neutral to a depth of 5 inches, mildly alkaline between depths of 5 and 13 inches, moderately alkaline between depths of 13 and 23 inches, and strongly alkaline below a depth of 23 inches.

Permeability is slow. Available water holding capacity is 2.5 to 6.0 inches. Water-supplying capacity is 6 to 7 inches. Effective rooting depth is 20 to 40 inches.

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

Representative profile of Simas cobbly silty clay loam, 10 to 35 percent slopes, located about 300 feet south of road in NW¼NE¼NE¼ sec. 36, T. 7 S., R. 18 E., Wasco County:

A1—0 to 5 inches, grayish-brown (10YR 5/2) cobbly silty clay loam, very dark grayish brown (10YR 3/2) moist; strong, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 20 percent cobblestones and 5 percent pebbles; neutral; abrupt, smooth boundary. 4 to 10 inches thick.

B21t—5 to 13 inches, brown (10YR 5/3) silty clay, very dark grayish brown (10YR 3/2) moist; moderate, fine and medium, subangular blocky structure and weak, medium, prismatic; very hard, very firm, very sticky and very plastic; many very fine roots; many, very fine, tubular pores; thick nearly continuous clay films on peds; 10 percent cobblestones and 5 percent pebbles; mildly alkaline; clear, smooth boundary. 5 to 8 inches thick.

B22t—13 to 18 inches, brown (10YR 5/3) silty clay, brown (10YR 4/3) moist; moderate, medium, subangular blocky structure and weak, medium, prismatic; very hard, very firm, very sticky and very plastic; few very fine roots; many, very fine, tubular pores; thick continuous clay films on peds; 10 percent cobblestones and 5 percent pebbles; moderately calcareous; moderately alkaline; clear, smooth boundary. 3 to 8 inches thick.

B3ca—18 to 23 inches, very pale brown (10YR 7/3) silty clay, brown (10YR 5/3) moist; weak, fine, prismatic structure and moderate, medium, subangular blocky; hard, firm, very sticky and very plastic; few very fine roots; many, very fine, tubular pores; moderately calcareous; myceliumlike lime; 10 percent cobblestones and 5 percent pebbles; moderately alkaline; clear, smooth boundary. 5 to 10 inches thick.

IIC1ca—23 to 27 inches, white (10YR 8/2) silt loam, pale brown (10YR 6/3) moist; massive; hard, firm, sticky and plastic; few very fine roots; common, very fine, tubular pores; moderately calcareous; myceliumlike lime; 15 percent cobblestones and 5 percent pebbles; strongly alkaline; gradual, wavy boundary. 3 to 8 inches thick.

IIC2ca—27 to 45 inches, pale-brown (10YR 6/3) to very pale brown (10YR 8/3) loam, brown (10YR 5/3) moist; massive; very hard, firm, slightly sticky and slightly plastic; few very fine roots; few, very fine, tubular pores; moderately calcareous; 15 percent cobblestones and 5 percent pebbles; strongly alkaline.

The surface layer is dark grayish brown or grayish brown when dry and very dark grayish brown or very dark brown when moist. It is heavy cobbly loam, cobbly silty clay loam, cobbly clay loam, or silt loam. The subsoil is grayish brown, brown, pale brown, or very pale brown when dry and brown or grayish brown when moist It is 40 to 60 percent clay Cobblestones and stones of basalt or rhyolite make up 10 to 30 percent of the profile, and pebbles make up 5 to 10 percent. Depth to lime is 10 to 20 inches

Simas cobbly silty clay loam, 10 to 35 percent slopes (SlE).—This soil is in irregularly shaped areas on broad. rolling ridgetops. It has the profile described as representative of the series.

Included with this soil in mapping were areas of Tub. Sorf, and Curant soils; shallow, very stony soils; and soils that are similar to this Simas soil, but are underlain by rhyolite or basalt. Areas of eroded soils where underlying tuff is exposed were also included.

Runoff is medium, and the hazard of erosion is slight to moderate. Capability unit VIe; Droughty South Exposure range site; wildlife group 4.

Simas very stony clay loam, 35 to 70 percent slopes (SmF).—This soil has south-facing slopes and is in long, narrow areas. It has a profile similar to the one described as representative of the series, but the surface layer is clay loam that is 20 to 30 percent stones.

Included with this soil in mapping were areas of Sorf, Lithgow, and Lickskillet soils; shallow, very stony, clayey soils; and soils that are similar to this Simas soil but are underlain by rhyolite or basalt. Areas of eroded soils where underlying tuff is exposed were also included.

Runoff is rapid, and the hazard of erosion is high. This soil is used for range, wildlife habitat, and water supply. Capability unit VIIs; Droughty Steep South range site; wildlife group 4.

Simas soils, 8 to 40 percent slopes (SnE).—This undifferentiated group consists of about 60 percent Simas silt loams and 25 percent deep silt loams. These soils are in long, narrow areas; have a variable pattern; and have north-facing slopes. The Simas soil has a profile similar to the one described as representative of the series, but the surface layer is silt loam 2 to 12 inches thick. The deep silt loams are similar to the Curant soils but are drier.

Included with this group in mapping were areas of Tub soils; shallow, very stony soils; and soils that are similar to this Simas soil but are underlain by rhyolite or basalt. These included areas make up as much as 15 percent of this mapping unit.

Runoff is medium, and the hazard of erosion is moderate. This soil is used for range, wildlife habitat, and water supply. Capability unit VIe; Droughty North Exposure range site; wildlife group 4.

Sorf Series

The Sorf series consists of well-drained soils that formed on uplands in fine-textured, calcareous colluvium. Slopes are 5 to 40 percent. Elevation is 1,300 to 2,500 feet. The vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 9 to 10 inches, average annual air temperature is 49 to 52° F., and the frost-free season is 80 to 120 days at 32° and 120 to 150 days at 28°.

In a representative profile the surface layer is light brownish-gray very stony loam about 5 inches thick. The upper part of the subsoil is grayish-brown and brown clay 7 inches thick. The lower part is pale-brown clay loam about 9 inches thick. The substratum is very pale brown clay loam. The soil is neutral to a depth of 12 inches and moderately alkaline to strongly alkaline between depths of 12 to 30 inches.

Permeability is slow. Available water holding capacity is 3 to 7 inches. Water-supplying capacity is 5 to 7 inches. Effective rooting depth is 20 to 40 inches.

These soils are used for range and wildlife habitat.

Representative profile of Sorf very stony loam, 5 to 40 percent slopes, located about 50 feet east of road in SW¼SW¼NE¼ sec. 12, T. 7 S., R. 18 E., Wasco County:

A1—0 to 5 inches, light brownish-gray (10YR 6/2) very stony loam, very dark grayish brown (10YR 3/2) moist; weak, medium, platy structure and very fine, weak, granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many, very fine, irregular pores and many vesicular pores in the upper part; 15 percent stones and 10 percent cobblestones; neutral; abrupt, smooth boundary. 1 to 6 inches thick.

IIB21t—5 to 9 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; strong, medium, prismatic structure and moderate, medium, subangular blocky; extremely hard, firm, very sticky and very plastic; many very fine and fine roots; many, very fine, tubular pores; few thin clay films on peds; 10 percent cobblestones; neutral; clear, smooth boundary. 3 to 6 inches thick.

IIB22t—9 to 12 inches, brown (10YR 5/3) clay, brown (10YR 4/3) moist; weak, medium, prismatic structure and moderate, medium, subangular blocky; very hard, firm, very sticky and very plastic; common very fine and fine roots; many, very fine, tubular pores; many thick clay films on peds; few large slickensides; common, yellowish-brown and light-gray, weathered, coarse (1 to 5 milimeters) fragments; 10 percent cobblestones; neutral; clear, wavy boundary. 3 to 10 inches thick.

IIB3ca—12 to 21 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; weak, fine and medium, subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine and fine roots;

many, very fine, tubular pores; strongly calcareous; common, light-gray lime segregations; moderately alkaline; clear, smooth boundary. 4 to 10 inches thick.

IIC1ca—21 to 30 inches, very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few roots; many, very fine, tubular pores; strongly calcareous and has segregations of lime; strongly alkaline.

The surface layer is gray or light brownish gray when dry and very dark grayish brown or dark grayish brown when moist. It is very stony loam or very stony clay loam Cobblestones and stones make up 20 to 35 percent of the surface layer. The subsoil is grayish brown, brown, or pale brown when dry and dark grayish brown, dark brown, or brown when moist It is 45 to 60 percent clay. The structure is weak to strong, prismatic and moderate to strong, subangular blocky and blocky. The subsoil, betweeen depths of 5 and 12 inches, is 5 to 35 percent cobblestones and stones. The substratum is 0 to 35 percent cobblestones and stones. Free lime is at a depth of 10 to 20 inches.

Sorf very stony loam, 5 to 40 percent slopes (SoE).—This soil is in irregularly shaped areas on broad, rolling ridgetops and has south-facing slopes.

Included with this soil in mapping were areas of Simas and Lithgow soils; shallow, very stony soils; medium-textured soils; and gray, clayey soils.

Runoff is medium to rapid, and the hazard of erosion is moderate to high. Capability unit VIIs; Droughty South Exposure range site; wildlife group 4.

Tub Series

The Tub series consists of well-drained soils that formed on uplands in fine-textured, old, calcareous colluvium. Slopes are 1 to 70 percent. Elevation is 2,700 to 4,000 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 11 to 14 inches, average annual air temperature is 45 to 48° F., and the frost-free season is 50 to 70 days at 32° and 90 to 130 days at 28°.

In a representative profile the surface layer is gray gravelly clay loam about 6 inches thick. The upper part of the subsoil is gray and brown clay loam and clay about 14 inches thick. The lower part is brown and pale-brown gravelly silty clay and gravelly clay loam about 17 inches thick. White cobbly loam is at a depth of about 37 inches. The soil is neutral to a depth of 12 inches, mildly alkaline between depths of 12 and 29 inches, and moderately alkaline below a depth of 29 inches.

Permeability is slow. Available water holding capacity is 3 to 7 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, wildlife habitat, and water supply.

Representative profile of Tub gravelly clay loam, 1 to 12 percent slopes, located about 300 feet west of Tub Springs Road, where the road turns northwest from due east-west on section line between secs. 27 and 34, T. 8 S., R. 16 E., Wasco County:

Ap—0 to 6 inches, gray (10YR 5/1) gravelly clay loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable, sticky and plastic; many very fine roots; many, fine, irregular pores; 20 percent pebbles; neutral; abrupt, smooth boundary. 6 to 9 inches thick.

B1t—6 to 12 inches, gray (10YR 5/1) clay loam, black (10YR 2/1) moist; weak, medium, prismatic structure and moderate, fine, subangular blocky; hard, firm, sticky and plastic; common very fine roots; many, very fine, tubular pores; nearly continuous thin clay films on peds and in pores; 15 percent pebbles; neutral; clear, smooth boundary. 0 to 7 inches thick.

B21t—12 to 20 inches, brown (10YR 5/3) clay, dark brown (10YR 3/3) moist; weak, medium, prismatic structure and moderate, medium, subangular blocky; hard, firm, sticky and very plastic; common very fine roots; many, very fine, tubular pores; 15 percent pebbles; continuous, thin, very dark brown (10YR 2/2) clay films on peds and in pores; mildly alkaline; clear, wavy boundary. 6 to 9 inches thick.

B22t—20 to 29 inches, brown (10YR 5/3) gravelly silty clay, dark brown (10YR 3/3) moist; moderate, medium, subangular blocky structure; hard, firm, very sticky and very plastic; common very fine roots; many, very fine, tubular pores; continuous thin clay films on peds and in pores; 20 percent pebbles; moderately calcareous; mildly alkaline; clear, wavy boundary. 6 to 12 inches thick.

B3ca—29 to 37 inches, pale-brown (10YR 6/3) gravelly clay loam, dark yellowish brown (10YR 4/4) moist; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; few, very fine, tubular pores; 20 percent pebbles and 10 percent cobblestones; thin nearly continuous clay films on peds; light-gray, soft, secondary lime; pebbles and cobblestones are lime coated; strongly calcareous; moderately alkaline; abrupt, wavy boundary. 0 to 10 inches thick.

IICca—37 to 40 inches, white (10YR 8/2) cobbly loam, light gray (10YR 7/2) moist; massive; hard, firm, slightly sticky and slightly plastic; few very fine pores; 15 percent pebbles and 15 percent cobblestones; strongly calcareous; moderately alkaline.

The surface layer is dark gray or gray when dry and black or very dark brown when moist. It is typically gravelly or cobbly clay loam but in places is loam. The area of the surface covered with stones ranges from 0 to 15 percent. The subsoil is dark brown, brown, pale brown, gray, or grayish brown when dry and black, dark brown, brown, or dark yellowish brown when moist. The structure in the upper part of the subsoil is weak to moderate, prismatic and moderate to strong, subangular blocky to angular blocky. The subsoil, above the calcareous zone, is 40 to 60 percent clay. The solum is gravelly or cobbly throughout and is as much as 15 percent cobblestones and 10 to 20 percent pebbles.

Tub gravelly clay loam, 1 to 12 percent slopes (TgC).—This soil is in irregularly shaped areas on broad ridgetops. It has the profile described as representative of the series.

Included with this soil in mapping were areas of McMeen, Simas, Degner, Curant, Day, and Prag soils and some areas of shallow or moderately deep soils.

Runoff is medium, and the hazard of erosion is slight to moderate. Capability unit IIIe–1; Droughty Rolling Hills range site; wildlife group 4.

Tub cobbly clay loam, 12 to 40 percent slopes (ThE).—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 it has a cobbly surface layer that contains more stones and is slightly shallower over tuff.

Included with this soil in mapping were areas of Degner and Simas soils; very stony, clayey soils; very stony, shallow or moderately deep soils; and rock outcrops.

Runoff is medium to rapid, and the hazard of erosion is moderate to high. This soil is used for range, pasture, wildlife habitat, and water supply. Capability unit VIe; South Exposure range site; wildlife group 4.

Tub very stony clay loam, 40 to 70 percent slopes (TuF).—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 very stony.

Included with this soil in mapping were areas of Degner and Simas soils; very stony, clayey soils; very shallow soils; and rock outcrops.

Runoff is rapid, and the hazard of erosion is high. This soil is used for range, wildlife habitat, and water supply. Capability unit VIIs; Steep South range site; wildlife group 4.

Tub very stony soils, 1 to 20 percent slopes (TvD).—This undifferentiated group consists of about 45 percent Tub very stony clay loams and about 40 percent very stony, shallow, clayey and loamy soils and very stony, moderately deep, clayey soils, none of which makes up more than 15 percent of the total area of the mapping unit. Individual areas can include any combination of two or more of these kinds of soil. These soils are in irregularly shaped areas on ridgetops or have moderately steep, south-facing slopes. The Tub soils have a profile similar to the one described as representative of the series, but the surface layer is as much as 30 percent stones.

Included with this undifferentiated group in mapping were areas of Donnybrook, Bakeoven, Degner, and McMeen soils that make up as much as 15 percent of this mapping unit.

Runoff is medium, and the hazard of erosion is slight to moderate. These soils are used for range, wildlife habitat, and water supply. Capability unit VIIs; Droughty Rolling Hills range site; wildlife group 4.

Utley Series

The Utley series consists of well-drained soils that formed on uplands in loess and colluvium weathered from shale. Slopes are 10 to 50 percent. Elevation is 3,800 to 4,500 feet. The vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 13 to 16 inches, average annual air temperature is 42 to 45° F., and the frost-free season is 30 to 60 days at 32° and 90 to 110 days at 28°.

In a representative profile the surface layer is dark grayish-brown shaly loam about 12 inches thick. The subsoil is brown heavy shaly loam about 14 inches thick. The substratum is pale-brown, shaly loam about 27 inches thick. Shale bedrock is at a depth of about 53 inches. Reaction is neutral throughout the profile.

Permeability is moderate. Available water holding capacity is 5 to 10 inches. Water-supplying capacity is 8 to 10 inches. Effective rooting depth is 40 to 60 inches.

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

Representative profile of Utley shaly loam, 10 to 50 percent slopes, located about 300 feet south of road in NW¼SW¼SW¼ sec. 30, T. 11 S., R. 16 E., Jefferson County:

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) shaly loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, fine, irregular pores; 20 percent shale fragments; neutral; clear, smooth boundary, 4 to 9 inches thick.

A12—4 to 12 inches, dark grayish-brown (10YR 4/2) shaly loam, very dark brown (10YR 2/2) moist; weak, fine, subangular blocky structure and moderate, very fine, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, tubular pores; 20 percent shale fragments; neutral; clear, smooth boundary. 8 to 10 inches thick.

B21—12 to 18 inches, brown (10YR 5/3) heavy shaly loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; 25 percent shale fragments; neutral; clear, smooth boundary 6 to 12 inches thick.

B22—18 to 26 inches, brown (10YR 5/3) heavy shaly loam, dark brown (10YR 3/3) moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; 25 percent shale fragments; neutral; clear, smooth boundary. 7 to 12 inches thick.

C1—26 to 32 inches, pale-brown (10YR 6/3) shaly loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common, very fine, tubular pores; 25 percent shale fragments; neutral; gradual, smooth boundary. 5 to 17 inches thick.

C2—32 to 53 inches, pale-brown (10YR 6/3) shaly loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; few, very fine, tubular pores; 25 percent shale fragments; neutral. 0 to 24 inches thick.

IIR—53 inches, shale bedrock.

The surface layer is dark grayish brown or grayish brown when dry and very dark brown or very dark grayish brown when moist. It is shaly loam or shaly silt loam that is 5 to 25 percent shale fragments that are 2 millimeters to 1 inch in diameter. The subsoil is grayish brown or brown when dry and dark brown or very dark grayish brown when moist. It is shaly loam or shaly clay loam that is 20 to 35 percent shale fragments that are 2 millimeters to 1 inch in diameter. The substratum is brown or pale brown when dry and dark brown or grayish brown when moist. Free lime is present in some profiles below a depth of 43 inches. Depth to fractured shale bedrock is 40 to 60 inches.

Utley shaly loam, 10 to 50 percent slopes (UtE).—This soil has north-facing slopes and is in long, narrow areas.

Included with this soil in mapping were areas of Venator and Prag soils and moderately deep, shaly soils.

Runoff is medium, and the hazard of erosion is moderate to high. Capability unit VIe; Shrubby North Exposure range site; wildlife group 6.

Venator Series

The Venator series consists of well-drained soils that formed on uplands in residuum and colluvium of shale origin. Slopes are 10 to 40 percent. Elevation is 4,000 to 4,500 feet. The vegetation is bunchgrasses, forbs, shrubs, and juniper trees. Average annual precipitation is 13 to 16 inches, average annual air temperature is 45 to 47° F., and the frost-free season is 50 to 70 days at 32° and 90 to 125 days at 28°.

In a representative profile the surface layer is dark grayish-brown and grayish-brown shaly loam about 8

inches thick. The subsoil is dark grayish-brown and brown very shaly clay loam about 8 inches thick. Bedrock is at a depth of about 16 inches. The soil is slightly acid to a depth of 8 inches and neutral between depths of 8 and 16 inches.

Permeability is moderately slow. Available water holding capacity is 1.5 to 3.0 inches. Water-supplying capacity is 4 to 6 inches. Effective rooting depth is 12 to 20 inches.

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

Representative profile of Venator shaly loam, 10 to 40 percent slopes, located about 2,200 feet south of the northeast corner on the section line in SE¼NE¼ sec. 25, T. 11 S., R. 15 E., Jefferson County:

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) shaly loam, very dark brown (10YR 2/2) moist; weak, thin, platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, irregular pores; 25 percent shale fragments, 1 to 3 inches long; slightly acid; clear, smooth boundary. 2 to 4 inches thick.

A12—4 to 8 inches, grayish-brown (10YR 5/2) shaly loam, very dark brown (10YR 2/2) moist; weak, thin, platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, irregular pores; 35 percent shale fragments, 1 to 3 inches long; slightly acid; clear, smooth boundary. 4 to 8 inches thick.

B21—8 to 12 inches, dark grayish-brown (10YR 4/2) very shaly clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; many, very fine, tubular pores; few thin clay films on fragments in some pores and between sand grains; 60 percent shale fragments, 1 to 3 inches long; neutral; clear, smooth boundary. 4 to 6 inches thick.

B22—12 to 16 inches, brown (10YR 5/3) very shaly heavy clay loam, dark brown (10YR 3/3) moist; weak to moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; many, very fine, tubular pores; few thin clay films on rock fragments in pores and between sand grains; 65 percent shale fragments, 1 to 3 inches long; neutral; abrupt, irregular boundary. 0 to 4 inches thick.

R—16 inches, fractured, extremely hard, unweathered shale bedrock and less than 10 percent soil; shale fragments are 1 to 3 inches long; few roots occur between fragments.

The surface layer is dark grayish brown or grayish brown when dry and very dark brown or very dark grayish brown when moist. It is loam or shaly loam that is 20 to 50 percent coarse fragments that are 2 millimeters to 3 inches in diameter. The subsoil is very shaly heavy loam to very shaly clay loam that is 40 to 80 percent coarse fragments that are 2 millimeters to 3 inches in diameter. The structure is moderate, fine and medium to weak, coarse, subangular blocky. Depth to bedrock is 12 to 20 inches.

Venator shaly loam, 10 to 40 percent slopes (VeE).—This soil is in long, narrow areas and has south-facing slopes.

Included with this soil in mapping were areas of Utley and Donnybrook soils.

Runoff is medium to rapid, and the hazard of erosion is slight to moderate. Capability unit VIe; Shrubby South Exposure range site; wildlife group 6.

Willowdale Series

The Willowdale series consists of well-drained soils that formed on bottom lands and alluvial fans in mixed recent alluvium and volcanic ash. Slopes are 0 to 2 percent. Elevation is 1,400 to 3,000 feet. Where these soils are not cultivated, the vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 9 to 12 inches, average annual air temperature is 47 to 51° F., and the frost-free season is 60 to 120 days at 32° and 120 to 150 days at 28°.

In a representative profile the surface layer is grayish-brown and dark grayish-brown loam about 24 inches thick. The underlying layer is grayish-brown and pale-brown loam about 24 inches thick. The soil is moderately alkaline throughout.

Permeability is moderate. Available water holding capacity is 7 to 12 inches. Water-supplying capacity is 6 to 7 inches. Effective rooting depth is 40 to 60 inches.

These soils are used for irrigated hay, pasture, dry-farmed small grain, range, wildlife habitat, and water supply.

Representative profile of Willowdale loam, located about 890 feet west and 110 feet south of the northeast corner of NE¼NE¼ sec. 17, T. 9 S., R. 15 E., Jefferson County:

Ap1—0 to 5 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, irregular pores; weakly calcareous in spots; moderately alkaline; clear, smooth boundary. 4 to 8 inches thick.

Ap2—5 to 11 inches, grayish-brown (10YR 5/2) loam, very dark brown (10YR 2/2) moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; some segregated lime; moderately alkaline; clear, wavy boundary. 0 to 8 inches thick.

A11—11 to 18 inches, grayish-brown (10YR 5/2) loam, very dark brown (10YR 2/2) moist; weak, coarse, prismatic structure and weak, medium, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; some segregated lime; 15 percent pumice sand; moderately alkaline; abrupt, wavy boundary. 4 to 8 inches thick.

A12—18 to 24 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak, coarse, prismatic structure and moderate, medium, subangular blocky; hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; some segregated lime; 10 percent pumice sand; moderately alkaline; abrupt, wavy boundary. 0 to 8 inches thick.

ACca—24 to 40 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many, very fine, tubular pores; strongly calcareous; moderately alkaline; clear, wavy boundary. 10 to 20 inches thick.

Cca—40 to 48 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many, very fine, tubular pores; some segregated lime; strongly calcareous; moderately alkaline.

The surface layer is dark gray, dark grayish brown, or grayish brown when dry and very dark grayish brown or very dark brown when moist. It is very fine sandy loam, silt loam, or loam. The stucture is weak or moderate and

granular, subangular blocky, or prismatic. In some places the soil is noncalcareous to a depth of 20 inches. The subsoil is gray, grayish brown, light brownish gray, or pale brown when dry and very dark grayish brown, very dark brown, or dark brown when moist. It is typically very fine sandy loam, silt loam, or loam but in places is gravelly or cobbly loam, sandy loam, or loamy sand below a depth of 40 inches Volcanic ash or pumice sand is present in thin lenses throughout the solum in some profiles. Depth to pebbles or cobblestones is 40 inches to more than 60 inches.

Willowdale loam (Wd).—This soil is in long, narrow areas along streams.

Included with this soil in mapping were areas of Rail soils, medium-textured gravelly soils, and Riverwash.

Runoff is slow, and the hazard of erosion is slight. This soil is subject to damage from flooding. Capability unit IIw–1; Moist Bottom range site; wildlife group 3.

Wrentham Series

The Wrentham series consists of well-drained soils that formed on uplands in loess mixed with some basalt colluvium. Slopes are 35 to 70 percent. Elevation is 1,000 to 3,600 feet. The vegetation is bunchgrasses, forbs, and shrubs. Average annual precipitation is 10 to 14 inches, average annual air temperature is 45 to 52° F., and the frost-free season is 60 to 100 days at 32° and 100 to 150 days at 28°.

In a representative profile the upper part of the surface layer is grayish-brown silt loam about 5 inches thick. The lower part is dark grayish-brown gravelly heavy silt loam about 4 inches thick. The subsoil is brown very cobbly clay loam about 19 inches thick. Bedrock is at a depth of 28 inches. The soil is slightly acid to a depth of 5 inches and neutral between depths of 5 to 28 inches.

Permeability is moderately slow. Available water holding capacity is 2 to 6 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 a Wrentham soil in an area of Wrentham-Rock outcrop complex, 35 to 70 percent slopes, located about 50 feet south of farm road in NW¼SW¼SE¼ sec. 31, T. 7 S., R. 15 E., Wasco County:

A11—0 to 5 inches, grayish-brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) moist; weak, thin, platy structure and weak, very fine, granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, irregular pores; 5 percent pebbles and 5 percent cobblestones and stones; slightly acid; clear, smooth boundary. 4 to 6 inches thick.

A12—5 to 9 inches, dark grayish-brown (10YR 4/2) gravelly heavy silt loam, very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure and moderate, very fine, granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many, very fine, tubular pores; about 20 percent pebbles and 5 percent cobblestones and stones; neutral; clear, smooth boundary. 4 to 10 inches thick.

B21—9 to 18 inches, brown (10YR 4/3) very cobbly clay loam, dark brown (10YR 3/3) moist; moderate, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; many, very fine, tubular pores; about 15 percent pebbles and 35 percent cobblestones and stones; neutral; gradual, smooth boundary. 5 to 20 inches thick.

B22—18 to 28 inches, brown (10YR 4/3) very cobbly clay loam, dark brown (10YR 3/3) moist; moderate, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; many, very fine, tubular pores; about 15 percent pebbles and 50 percent cobblestones and stones; neutral; abrupt, wavy boundary. 7 to 12 inches thick.

IIR—28 inches, basalt fragments and bedrock.

The surface layer is dark gray, dark grayish brown, or grayish brown when dry and very dark brown or very dark grayish brown when moist. Cobblestones and stones make up 5 to 20 percent of the surface layer, pebbles 5 to 20 percent, and rock outcrops about 10 to 15 percent. The subsoil is dark brown or brown when dry and dark brown when moist. It is very cobbly loam, very cobbly silt loam, or very cobbly silty clay loam that is 20 to 30 percent clay, 35 to 60 percent cobblestones and stones, and 5 to 20 percent pebbles. The structure is weak or moderate, subangular blocky. Depth to basalt bedrock is 20 to 40 inches.

Wrentham-Rock outcrop complex, 35 to 70 percent slopes (WrF).—This complex has steep to very steep, convex, north-facing slopes and is in long, narrow areas. The Wrentham soil has the profile described as representative of the series.

Included with this complex in mapping were areas of Condon and Bakeoven soils and Rock outcrop and Rubble land.

Runoff is rapid, and the hazard of erosion is high. Capability unit VIIs; Steep North range site; wildlife group 1.

Yawkey Series

The Yawkey series consists of well-drained soils that formed on uplands in volcanic ash that contains basalt colluvium and clay. Slopes are 30 to 70 percent. Elevation is 3,500 to 5,000 feet. The vegetation is Douglas-fir, ponderosa pine, elk sedge, forbs, and shrubs. Average annual precipitation is 16 to 25 inches, average annual air temperature is 40 to 45° F., and the frost-free season is 10 to 50 days at 32° and 80 to 100 days at 28°.

In a representative profile the upper part of the surface layer is gray gravelly loam about 6 inches thick. The lower part is dark grayish-brown gravelly clay loam about 7 inches thick. The subsoil is brown very gravelly clay about 17 inches thick. The substratum is brown very gravelly clay and extends to a depth of 48 inches or more. The soil is slightly acid to a depth of 6 inches and neutral between depths of 6 and 48 inches.

Permeability is moderately slow. Available water holding capacity is 2 to 7 inches. Water-supplying capacity is about 8 inches. Effective rooting depth is 40 inches to more than 60 inches.

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

The Yawkey series is mapped only in an undifferentiated group with Boardtree soils.

Representative profile of a Yawkey gravelly loam in an area of Boardtree and Yawkey gravelly loams, 20 to 70 percent slopes, located 280 feet south of road in NE¼NW¼ sec. 31, T. 11 S., R. 18 E., Jefferson County:

O1—2½ inches to 0, partly decomposed fir needles, twigs, and leaves. 0 to 3 inches thick.

A11—0 to 6 inches, gray (10YR 5/1) gravelly loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine to medium roots;

many, very fine, irregular pores; 20 percent pebbles and 5 percent cobblestones and stones; slightly acid; gradual, smooth boundary. 3 to 7 inches thick.

A12—6 to 13 inches, dark grayish-brown (10YR 4/2) gravelly clay loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; slightly hard, friable, sticky and plastic; many very fine to medium roots; many, very fine, irregular pores; 40 percent pebbles and 10 percent cobblestones and stones; neutral; clear, wavy boundary. 4 to 7 inches thick.

B2—13 to 30 inches, brown (10YR 5/3) very gravelly clay, dark brown (10YR 3/3) moist; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; few very fine to medium roots; many, very fine, tubular pores; 40 percent pebbles and 10 percent cobblestones; 10 percent stones; neutral; gradual, smooth boundary. 13 to 25 inches thick.

C—30 to 48 inches, brown (10YR 5/3) very gravelly clay, brown (10YR 4/3) moist; massive; hard, friable, sticky and plastic; few very fine to medium roots; many, very fine, irregular pores; 65 percent pebbles, 15 percent cobblestones, and 5 percent stones; neutral 18 to 30 inches thick.

The surface layer is dark grayish brown, grayish brown, or gray when dry and very dark brown or very dark grayish brown when moist. The subsoil is brown or grayish brown when dry and dark brown or brown when moist It is very gravelly or very cobbly clay or clay loam that is more than 35 percent clay, 35 to 50 percent pebbles, and 5 to 20 percent cobblestones and stones. The substratum is yellowish brown or brown when dry and brown or dark yellowish brown when moist. It is 35 to 45 percent clay, 35 to 65 percent pebbles, and 5 to 20 percent cobblestones and stones. Depth to bedrock is 40 inches to more than 60 inches.

Use and Management of the Soils

This section describes principles of soil management, capability groups of soils, estimated yields of principal crops, and the management of the soils when used for range, woodland, wildlife habitat, and engineering.

Management Needs [2]

Different soils require different management, and the same soil can require variations in management from year to year or from crop to crop. Following are descriptions of the basic management needs.

Conserving moisture.—Most cultivated soils in the Trout Creek-Shaniko Area have limited suitability for crops because of inadequate moisture. It is important, therefore, to conserve and use efficiently all the moisture that is available. During the fallow season, evaporation loss can be kept to a minimum by maintaining a surface mulch and by tilling only as much as is needed to control weeds.

Controlling erosion.—Many soils in the Trout Creek-Shaniko Area are shallow or moderately deep. Soil erosion reduces the capacity of soils to store moisture and supply nutrients. Proper tillage, maintenance of organic-matter content, and preservation of soil structure help to control erosion.

Preserving soil structure.—Proper tillage and maintenance of organic-matter content are the two main factors in building and preserving good soil structure. Excessive tillage while the soil is fallow destroys organic matter and soil aggregates. This tends to reduce the permeability of the soil to water, air, and roots.

Maintaining organic-matter content.—Organic matter is mostly the remains of plants and soil organisms. The organic-matter content of the surface layer of the soils in the Trout Creek-Shaniko Area ranges from a high of 3 to 4 percent, under native plant cover, to a low of 1 or 2 percent, after a long period of cultivation.

Organic matter helps to bind soil particles together in aggregate and, thus, has a beneficial effect on soil structure. It is a source of plant nutrients and of energy for soil micro-organisms, and it provides an important part of the nutrient-holding capacity of the soils.

The organic matter in the soil is constantly decomposing if the soil temperature is above about 41° F. Therefore, the supply of organic matter must be renewed regularly and often. An adequate supply can be maintained by—

1. Returning to the soil all crop residue, which is the main source of organic matter. Organic matter is lost if residue is burned or otherwise destroyed. A common practice is to graze cattle on stubble and straw dumps, thereby returning organic matter to the soil in the form of manure.
2. Using commercial fertilizer to produce larger yields and greater amounts of residue and to supply nitrogen to soil organisms.
3. Growing grass and legumes in the cropping system to provide a readily usable supply of organic material that decomposes rapidly and speeds the release of plant nutrients.

Providing proper irrigation water management.—Leveling is needed before surface irrigation of most soils in the survey area. 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 job of leveling, some floating is needed at least once a year to eliminate high spots and fill low spots, so that crops can be irrigated uniformly and without wasting water. Ordinarily, several years of floating are required before a field is properly leveled and distribution of water is fast and efficient. 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 holding capacity, and permeability are important for properly designed systems.

Cropping Systems

The number and variety of cropping systems used in the Trout Creek-Shaniko Area are limited by the small amount of precipitation and the shortage of wells or accessible surface water for irrigation. The main cropping system is grain-fallow. Other dryland cropping systems are grass or grass and alfalfa in a rotation with grain.

[2] JOHN DENISON, conservation agronomist, and DONALD J VANDERVELDEN, district conservationist, Soil Conservation Service, helped to prepare this subsection.

Most cropland in the Trout Creek-Shaniko Area is used for grain-fallow farming. In grain-fallow dryland farming, the soil is kept free of vegetation during one cropping season in order to store additional moisture and plant nutrients for a crop the following season. This practice also helps to control weeds.

The most common method of fallowing is to permit the stubble from a crop to stand during winter. The soil is tilled in March or April, before weeds have removed much moisture and before the surface becomes too dry. Tillage is also performed during summer to keep the soil free of weeds and to prepare a seedbed for fall planting. If spring crops are grown, the soil is left rough through winter.

The grain-fallow cropping system has increased yields of grain as compared to annual cropping systems and has tended to stabilize production. Weeds, plant diseases, and insects can be controlled more effectively if the soil is fallowed periodically. However, the hazard of soil erosion is generally greater under the grain-fallow system than under continuous cropping.

The grain-fallow cropping system has been used in the Trout Creek-Shaniko Area since before the turn of the century. Only about a third of the precipitation that falls during a 2-year period is used by crops. Some water is lost through evaporation from fallow soils. In some years runoff is rapid because of slow infiltration on finely tilled seedbeds or frozen ground. These kinds of concerns cause farmers and research workers to seek improved cropping systems.

Annual cropping has not proved successful in the Trout Creek-Shaniko Area.

A small acreage in the Trout Creek-Shaniko Area is used for a rotation of grass and legumes with grain and fallow. This rotation increases the supply of organic matter and soil nutrients and the rate of water infiltration and helps to reduce soil erosion.

Grasses and legumes can be used for rotation hay or pasture. Grasses and legumes seeded on fallow soils or in spring of the stubble year generally can be used for forage the second year.

Plowing the grass-legume sod and rotating to other fields should be done at about the time of maximum root growth. Soils used for grass-legume rotations are plowed and seeded to grain every 4 or 5 years. A successful grass-legume seeding requires a firm seedbed and a suitable mixture of good-quality seed.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk 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 slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops 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 soil 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. (None in the Trout Creek-Shaniko Area.)

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 plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat. (None in the Trout Creek-Shaniko Area.)

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

Class VII soils have very severe limitations that make them unsuited to 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 commmercial 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* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil intereferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States but not in the Trout Creek-Shaniko Area, shows that the chief limitation is climate that is too cold or too dry.

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

Management by capability units

In the following pages the capability units in the Trout Creek-Shaniko Area are described and suggestions for the use and management of the soils are given.

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 series appear in the unit. To find the names of all the soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT IIw–1

This capability unit consists only of Willowdale loam. This is a well-drained soil that is 40 inches to more than 60 inches deep over pebbles or cobblestones. It formed in mixed alluvium and volcanic ash on alluvial fans and bottom lands. This soil is occasionally flooded and is subject to channeling and washing. Slopes range from 0 to 2 percent. Precipitation ranges from 9 to 12 inches. The frost-free period is 60 to 120 days at 32° F. and 120 to 150 days at 28°.

Permeability of this soil is moderate. Available water holding capacity ranges from 7 to 12 inches. Water-supplying capacity ranges from 6 to 7 inches. Typically, the range in root penetration is from 40 to 60 inches, or to the pebbly or cobbly substratum. Runoff is slow, and the hazard of erosion is slight.

This soil is well suited to irrigation and is used mainly for irrigated hay and pasture. Other uses include dryfarmed small grain, hay and pasture, range, wildlife habitat, and water supply. Wheat and barley are the principal grains. Legumes and perennial grasses are suitable pasture and hay crops.

Irrigated alfalfa or alfalfa and grass is grown for hay for winter feed. Most haylands are used for aftermath grazing, when livestock are brought in from the range. The crop rotation commonly consists of hay grown for 5 to 8 years and grain for 1 year. For an alfalfa and grass mixture, only one variety of each is desirable. Crops respond to nitrogen fertilizer and sulfur. Irrigation water is available from streamflow until about July 1. Methods of irrigation include the wild-flooding, corrugation, border, and sprinkler systems. Deep cuts are necessary for land leveling in some fields. The trend is to sprinkler irrigation, which takes advantage of low streamflow. Rodents are commonly a concern where alfalfa is grown. Fields along the streams generally need to have the streambank protected from erosion.

Dryfarmed grain-fallow in a long-term rotation with legumes and perennial grasses is suited to this soil. Stubble-mulch tillage increases the rate of water intake and reduces loss of nutrients and soil by erosion. Streambank protection and channel realinement help to reduce streambank erosion and overflow. Small grain and pasture plants respond to additions of nitrogen. Mechanical and chemical methods of controlling both annual and perennial weeds are widely used.

CAPABILITY UNIT IIIe–1

This capability unit consists of Condon, McMeen, and Tub soils. These are well-drained silt loams and clays. Slopes range from 1 to 12 percent. Precipitation ranges from 10 to 14 inches. The frost-free period is 50 to 140 days at 32° F. and 90 to 170 days at 28°.

Permeability of these soils ranges from moderate to slow. Available water holding capacity ranges from 3 to 9 inches. Water-supplying capacity ranges from 6 to 10 inches. Typically, the range in root penetration is from 20 to 40 inches. Runoff ranges from slow to medium, and the hazard of erosion ranges from slight to moderate.

These soils are used for dryfarmed small grain, hay, pasture, range, wildlife habitat, and water supply. Wheat and barley are the principal grains. Legumes and perennial grasses are suitable pasture and hay crops.

A grain-fallow system of dryfarming is commonly used. In the fallow year, a seedbed is started in spring with chisels or sweeps, disks, and rod weeders. Control of weeds and retention of soil moisture is by the use of rod weeders. Nitrogen fertilizer is applied in fall at the time of seeding. Several winter wheat varieties are suitable, and seeding early in fall provides cover for control of erosion. Annual weeds are generally controlled in spring by the use of chemicals. Grain is harvested in bulk, and the straw is scattered or dumped. Cloddy fallow, minimum tillage, and stubble mulch tillage slow surface runoff, increase the rate of water intake, and reduce loss of nutrients and soil erosion. Cross-slope cultivation and seeding, stripcropping (fig. 9), and using diversions on long slopes reduce runoff and erosion. Seeded waterways remove excess water.

If a crop rotation is used, a perennial grass or grass and alfalfa grown for 5 years produces maximum root development.

CAPABILITY UNIT IIIw–1

This capability unit consists only of Mixed alluvial land. This is a well-drained land type that has a seasonal high water table in some areas at higher elevations. Most areas have a texture of sandy loam to clay loam, and there is some sand, gravel, and cobblestones. This unit occupies alluvial flood plains, is occasionally flooded, and is subject to channeling and washing. Slopes range from 0 to 2 percent. Precipitation ranges from 9 to 16 inches. The frost-free period is 30 to 120 days at 32° F. and 80 to 150 days at 28°. Areas of this unit in the southeastern part of the survey area, at elevations of more than 3,500 feet, have an annual precipitation of 16 to 25 inches and a frost-free period of 10 to 30 days at 32° F. and 80 to 100 days at 28°. Areas at elevations of less than 2,000 feet, along the John Day River, have a growing season of 130 to 150 days at 32°.

Permeability of this land ranges from slow to moderately rapid. Runoff is slow, and the hazard of erosion is slight. Available water holding capacity and water-sup-

Figure 9.—**Grain-fallow dryfarming and stripcropping in area of Tub gravelly clay loam, 1 to 12 percent slopes.**

plying capacity are variable. Typically, roots penetrate to the gravelly or sandy substratum.

This soil is used mainly for irrigated hay and pasture. Other uses include hay and pasture, range, wildlife habitat, and water supply. Legumes and perennial grasses are suitable pasture and hay crops. In areas of less than 90 frost-free days, use is limited to range, wildlife habitat, and water supply.

Irrigated alfalfa or alfalfa and grass is grown for hay for winter feed. Most haylands are used for aftermath grazing, when livestock are brought in from the range. The crop rotation commonly consists of hay grown for 5 to 8 years and grain for 1 year. For an alfalfa and grass mixture, only one variety of each is desirable. Crops respond to nitrogen fertilizer and sulfur. Irrigation water is available from streamflow until about July 1. Methods of irrigation include the wild-flooding, corrugation, border, and sprinkler systems. Cuts for land leveling are limited by the depth to the gravelly or sandy substratum. The trend is to sprinkler irrigation, which takes advantage of low streamflow. Rodents are a concern where alfalfa is grown.

Streambank protection and channel realinement help to reduce streambank erosion (fig. 10) and overflow.

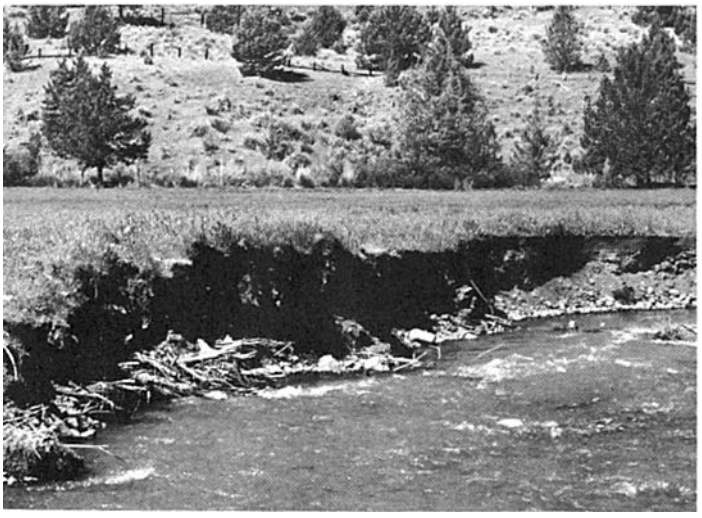

Figure 10.—**Streambank washout on Mixed alluvial land along Trout Creek. Surrounding soils are in Tub series.**

CAPABILITY UNIT IVe-1

This capability unit consists of Court, Era, and Metolius soils. These are well-drained to somewhat excessively drained sandy loams or loams that formed in mixed sandy eolian and alluvial materials that are as much as 60 percent pumice. They occupy concave depressions and areas along drainageways. Slopes range from 0 to 8 percent. Precipitation ranges from 9 to 12 inches. The frost-free period is 50 to 80 days at 32° F. and 100 to 130 days at 28°.

Permeability of these soils is moderately rapid. Available water holding capacity ranges from 3 to 13 inches. Water-supplying capacity ranges from 5 to 7 inches. Typically, roots penetrate to a depth of 40 inches or more. Runoff is slow, and the hazard of erosion is slight.

These soils are well suited to all irrigated crops grown in the area and are used mainly for range and perennial pasture, irrigated hay, wildlife habitat, and water supply. Small areas are used for dryfarmed small grain. Wheat and barley are the principal grains.

These soils are droughty and are subject to soil blowing and water erosion. Seedbed preparation for grain is done in spring. Nitrogen fertilizer is generally applied at the time of seeding. Forage plants, such as crested wheatgrass, can be safely used by delaying grazing until there is a growth of 4 to 6 inches in spring and by leaving a stubble of 3 to 4 inches in fall. Rodents are a potential concern where alfalfa is grown. Cloddy fallow, minimum tillage, and stubble-mulch tillage slow surface runoff, prevent soil blowing, increase the rate of water intake, and reduce loss of nutrients and soil by erosion. Cross-slope cultivation and seeding and diversions on long slopes reduce runoff and erosion. Seeded waterways remove excess water.

CAPABILITY UNIT IVe–2

This capability unit consists of Agency, Lamonta, Madras, and McCoin soils. These are well-drained soils that have a surface layer of loam or cobbly loam and a subsoil of loam, clay loam, gravelly clay loam, or cobbly clay. They formed on upland plateaus in loess and in material weathered from sandstone, siltstone, conglomerate, and tuff. Slopes range from 1 to 20 percent. Precipitation ranges from 9 to 12 inches. The frost-free period is 50 to 80 days at 32° F. and 100 to 130 days at 28°.

Permeability of these soils ranges from moderate to very slow. Available water holding capacity ranges from 2 to 6 inches. Water-supplying capacity ranges from 5 to 8 inches. Runoff is slow to medium, and the hazard of erosion is slight to moderate.

These soils are used for dryfarmed small grain, hay and pasture, range, wildlife habitat, and water supply. Wheat and barley are the principal grains. Legumes and perennial grasses are suitable pasture and hay crops.

A grain-fallow system of dryfarming is commonly used. In the fallow year, a seedbed is started in spring with chisels or sweeps, disks, and rod weeders. Control of weeds and retention of soil moisture is by the use of rod weeders. Nitrogen fertilizer is applied in fall at the time of seeding. Several winter wheat varieties are suitable, and seeding early in fall provides cover for control of erosion. Annual weeds are controlled in spring by the use of chemicals. Grain is harvested in bulk, and the straw is scattered or dumped. Cloddy, minimum tillage, and stubble-mulch tillage slow surface runoff, increase the rate of water intake, and reduce loss of nutrients and soil by erosion. Cross-slope cultivation and seeding, stripcropping, and using diversions on long slopes reduce runoff and erosion. Seeded waterways remove excess water.

If a crop rotation is used, a perennial grass or grass and alfalfa grown for 5 years produces maximum root development.

CAPABILITY UNIT IVw–1

This capability unit consists of Playas and Rail soils. These are somewhat poorly drained clays that formed in alluvium along streams and in nearly level depressions that formerly were the bottoms of lakes. Slopes range from 0 to 2 percent. Precipitation ranges from 10 to 14 inches. The frost-free period is 50 to 150 days at 32° F. and 90 to 170 days at 28°.

Permeability of these soils is slow to very slow. The Rail soils are subject to channel cutting. These soils have a clay subsoil that seals tightly when wet and cracks as it dries. Available water holding capacity ranges from 6 to 12 inches. Water-supplying capacity ranges from 6 to 9 inches. Typically, roots penetrate to a depth of more than 40 inches. Runoff is slow, and the hazard of erosion is slight.

These soils are used for dryfarmed small grain, hay and pasture, range, wildlife habitat, and water supply. Wheat and barley are the principal grains. Legumes and perennial grasses are suitable pasture and hay crops.

These soils crack when dry and are difficult to work. Wetness in spring delays tillage. The seeding of suitable grasses is commonly done in fall. Forage plants, such as intermediate or pubescent wheatgrass, can be safely grazed by delaying use until there is a growth of 8 to 10 inches in spring and by leaving a stubble 4 to 6 inches tall in fall. Rodents are not commonly a concern. Rough tillage and the use of crop residue and other mulching materials improve workability. Small grain responds to additions of nitrogen.

CAPABILITY UNIT VIe

This capability unit consists of Bakeoven, Condon, Curant, Degner, Donnybrook, Era, Ginser, Gribble, Lithgow, Prag, Simas, Sorf, Tub, Utley, and Venator soils. These are well-drained soils that formed in loess; eolian material; material weathered from sandstone, siltstone, conglomerate, and tuff; and colluvium derived from shale. Slopes range from 2 to 50 percent. Precipitation ranges from 9 to 16 inches. The frost-free period is 30 to 140 days at 32° F. and 90 to 170 days at 28°.

Permeability of these soils ranges from very slow to moderately rapid. Available water holding capacity ranges from 1.5 to 12.0 inches. Water-suppling capacity ranges from 2.5 to 10.0 inches. Typically, the range in root penetration is from 4 to 40 inches or more. Runoff ranges from slow to rapid, and the hazard of erosion ranges from slight to high.

These soils are used for range, pasture, wildlife habitat, and water supply. Legumes and perennial grasses are suitable pasture crops.

CAPABILITY UNIT VIIe

This capability unit consists of Boardtree, Curant, Day, Ginser, Hankins, Prag, Tub, and Yawkey soils. These are well-drained soils that formed on uplands in volcanic ash mixed with basalt colluvium and material weathered from tuffs and conglomerates. Slopes range from 8 to 70 percent. Precipitation ranges from 9 to 25 inches. The frost-free period is 10 to 120 days at 32° F. and 80 to 150 days at 28°.

Permeability of these soils ranges from moderately rapid to very slow. Available water holding capacity

ranges from 2 to 12.5 inches, and water-supplying capacity ranges from 6 to 20 inches. Typically, the range in root penetration is from 20 inches to more than 60 inches. Runoff ranges from medium to very rapid, and the hazard of erosion ranges from moderate to high.

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

CAPABILITY UNIT VIIs

This capability unit consists of Bakeoven, Condon, Ginser, Lickskillet, Lithgow, deep variant, Madras, Prag, Searles, Simas, Sorf, and Tub soils; Rough broken and stony land; and Wrentham-Rock outcrop complex, 35 to 70 percent slopes. These are well-drained soils that formed on uplands in basalt colluvium; loess; and material weathered from sandstone, siltstone, conglomerate, and tuff. Slopes range from 1 to 70 percent. Precipitation ranges from 9 to 16 inches. The frost-free period is 30 to 150 days at 32° F. and 90 to 170 days at 28°.

Permeability is moderately rapid to slow. Available water holding capacity ranges from 1 to 9 inches. Water supplying capacity ranges from about 2 to 10 inches. Typically, the depth in root penetration is from 4 inches to more than 60 inches. Runoff is slow to rapid, and the hazard of erosion is slight to high.

CAPABILITY UNIT VIIIs

This capability unit consists only of the Rock outcrop-Rubble land complex. This land type is made up of very steep, rocky areas; steep, severely eroded areas; and basalt cliffs that are barren and have little or no value for farming.

This land is used for wildlife habitat, for water supply, and as a source of material for roads and other construction.

CAPABILITY UNIT VIIIw

This capability unit consists only of Riverwash. This land type is subject to flooding and shifting during normal high water and has little or no value for farming.

This land type is used for wildlife habitat and as a source of material for roads and other construction.

Estimated Yields

Table 2 shows estimated average acre yields of selected crops for most soils in the survey area. The soils and land types omitted from table 2 are mainly those that

TABLE 2.—*Estimated average acre yields of selected crops*

[Absence of entry indicates soil is not suited to crop, or that the crop is not ordinarily grown on the soil. Only those soils commonly used for crops are listed in the table]

Soil	Winter wheat [1]	Spring barley [1]	Hay		Pasture	
			Alfalfa-grass	Grass	Alfalfa-grass	Grass
	Bu.	*Bu.*	*Lbs*	*Lbs*	*A U.M.*[2]	*A.U.M.*[2]
Agency loam, 1 to 12 percent slopes	20	25	1, 000	550	0. 75	0. 50
Condon silt loam, 2 to 12 percent slopes	30	30	1, 500	850	1. 50	1. 00
Condon-Bakeoven complex 2 to 20 percent slopes	20	20	1, 100	650	1. 00	. 75
Court sandy loam, 1 to 8 percent slopes	20	25	700	500	75	. 50
Curant and Tub silt loams, 8 to 40 percent slopes			2, 000	1, 000	2. 00	1. 25
Degner gravelly loam, 12 to 40 percent slopes			1, 750	850	1. 50	1. 00
Degner soils, 2 to 12 percent slopes			1, 200	650	. 75	. 50
Donnybrook stony loam, 10 to 40 percent slopes					. 75	. 50
Era soils, 1 to 8 percent slopes	20	20	700	500	. 75	. 50
Era soils, 8 to 40 percent slopes	20	25	1, 000	550	. 75	. 50
Ginser gravelly silt loam, 12 to 40 percent slopes					1. 25	. 75
Gribble cobbly loam, 5 to 20 percent slopes			1, 200	650	. 75	. 50
Lamonta cobbly loam, 1 to 12 percent slopes	20	25	1, 000	550	. 75	. 50
Lithgow and Sorf soils, 20 to 50 percent slopes					. 50	. 50
Madras loam, 1 to 12 percent slopes	20	25	700	500	. 75	. 50
McCoin loam, 5 to 20 percent slopes	20	25	1, 000	550	. 75	. 50
McMeen silt loam, 1 to 12 percent slopes	30	30	2, 000	1, 000	2. 00	1. 25
Metolius sandy loam, 0 to 8 percent slopes	20	25	1, 000	550	. 75	. 50
Mixed alluvial land [3]			[4] 14, 000		[4] 16. 00	
Prag cobbly loam, 5 to 40 percent slopes					1. 50	1. 25
Rail clay	[4] 40	[4] 50	[4] 8, 000			[4] 11. 00
Simas cobbly silty clay loam, 10 to 35 percent slopes					. 75	. 50
Simas soils, 8 to 40 percent slopes			1, 000	550	. 75	. 50
Tub cobbly clay loam, 12 to 40 percent slopes			1, 000	550	. 75	. 50
Tub gravelly clay loam, 1 to 12 percent slopes	25	30	1, 500	850	1. 50	1. 00
Utley shaly loam, 10 to 50 percent slopes					1. 25	. 75
Venator shaly loam, 10 to 40 percent slopes					. 75	. 50
Willowdale loam [3]	[4] 70	[4] 65	[4] 14, 000		[4] 16. 00	

[1] Yields for winter wheat and spring barley are for year of harvest, which is every 2 years

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

[3] Yields are for areas at lower elevations.

[4] Yields are for crops grown with irrigation.

are very high in rock fragments, very steep, in woodland, or generally not used for farming or ranching. Estimated yields are based on the most common combination of management practices used by most farmers and ranchers in the Trout Creek-Shaniko Area. The estimated yield for dryfarmed wheat and barley is for the year of harvest, or every 2 years. It is based on data from the Agricultural Stabilization and Conservation Service records for the determination of the 10-year cereal grain base. Most dryfarmed soils in the survey area are included in the Agricultural Stabilization and Conservation Service records.

The yield data for dryland grass and alfalfa are based on leaving a 50-percent stubble. These data are estimated from actual use records, clipping information, and observations. Estimated yields of irrigated crops are based on the records of farmers. Yields of Gaines wheat are not included in the table.

Range [3]

Approximately 90 percent of the Trout Creek-Shaniko Area is in range. Broad differences in soil, climate, and topography separate the survey area into two general types of range. North of Shaniko Ridge, loams and silt loams that formed in loess are predominant. Bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass make up nearly 100 percent of the original plant community in this area. In the southern part of the survey area, clay loams and silty clay loams that formed in colluvium and residuum are predominant. They support a cover of native bunchgrass, western juniper, and a variety of shrubs. Along the southern boundary of the survey area, conifer forests are on the fringe of the Ochoco Mountains. This area of about 56,000 acres provides valuable summer grazing for livestock.

A major concern in the Trout Creek-Shaniko Area in recent years is the spread of juniper over much of the range (fig. 11). Prior to 1900, juniper was mostly confined to rocky south-facing slopes, ridges, and dry canyons. Since 1934, the area dominated by juniper has increased from about 25,000 acres to more than 200,000 acres. Forest maps and landscape photos made since 1900, conversations with old-time residents, and personal observations support this contention. Overgrazing by an extremely large number of livestock from 1890 to 1920, followed by the severe drought of the 1930's, brought about deterioration of the range and provided space for juniper encroachment. During periods of good moisture and lack of fires, reproduction of juniper rapidly increased. According to ring counts made of representative trees in the vicinity of Pony Creek in Jefferson County, nearly all trees from present-day juniper stands are less than 80 years old.

[3] By SAMUEL F. GREENFIELD, JR., range conservationist, Soil Conservation Service, Bend, Oregon.

Figure 11.—**Young stand of juniper trees on Tub cobbly clay loam, 12 to 40 percent slopes.**

Range sites and condition classes

A range site is a distinctive kind of range that differs from other kinds of range in its potential to produce native plants. A range site is the product of all environmental factors responsible for its development. In the absence of abnormal disturbances and physical deterioration of the site, it supports a plant community characterized by an association of species different from that of other range sites in terms of the kind or proportion of species or in total annual production.

Range condition is the present state and health of the soil-vegetation complex of a range site in relation to the soil and vegetation that is natural for that site. Range condition is commonly expressed as excellent, good, fair, or poor. These classes represent the degree to which the present plant community of a range site, expressed as a percentage, has departed from that of the original as a result of such factors as grazing, fire, erosion, and drought. A range is in *excellent condition* if 75 percent of the vegetation is of the same kind as that in the original stand and if there is no current erosion; it is in *good condition* if the percentage is between 50 and 75 percent and erosion is no more than slight; it is in *fair condition* if the percentage is between 25 and 50 percent and erosion is no more than moderate; and it is in *poor condition* if the percentage is less than 25 percent and erosion is severe.

The key forage plants on range normally are the most productive and, also, the most palatable to livestock. Bluebunch wheatgrass and Idaho fescue are the main forage plants in this survey area. The trend in range condition generally can be judged or predicted on the basis of the stand of these plants on the site, the degree of use, and the vigor of these key plants.

Grazing is critical for most forage plants in spring or during the early stages of growth, when food reserves are being used up in the production of new leaves, stems, and roots. New growth is needed for the production of plant food, or carbohydrates. Removal of green leaves and new twig growth becomes less critical as the growing season advances, allowing a greater percentage of the foliage to be taken without disrupting normal plant regrowth or survival.

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 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.

There are two major kinds of forest plant communities within the survey area. They are identified as the Pine-Bunchgrass and Mixed Fir-Pine Forest range sites.

A second critical period, particularly for grasses, occurs at the end of the grazing season. Safe use at this time recognizes the need for leaving part of the current year's growth ungrazed. The lower stems of grass contain stored food that provides the energy needed for winter dormancy, insulation against cold, and vigorous growth the following spring. Also, grass stubble catches and holds snow in winter, provides for the recycling of a large amount of organic matter and nutrients, and protects the soil against soil blowing and water erosion.

Range deterioration often is a result of grazing too early in spring, when the soil is wet and soft. Soil and plant damage through livestock trampling occurs particularly on clayey soils saturated with water. If the ground is in this condition, trampling causes compaction of the soil surface and weakens or dislodges the roots of seedlings and young plants. If continued for several seasons or over a period of years, trampling damage reduces the stand of forage plants and restricts entry of water into the soil, thereby increasing soil and water loss through runoff.

Descriptions of the range sites

There are 25 range sites in the survey area. Each site is described as it occurs in near-climax condition and according to the important changes that take place as the site deteriorates. The site description also lists both the potential forage production for cattle and the total annual production of all species that can be expected from this site in years of favorable moisture and in dry years. Usable forage production is a management consideration that is not covered in this discussion of range. The texture given for the soils is that of the surface layer, unless otherwise noted.

The names of soil series represented are mentioned in the description of each range site, but this does not mean that all the soils of a given series are on the site. To find the names of all the soils on any given site, refer to the "Guide to Mapping Units" at the back of this survey.

ROLLING HILLS RANGE SITE

This range site is only on Condon silt loam, 2 to 12 percent slopes. These are well-drained silt loams that formed in loess on broad ridgetops and rolling uplands. Elevation ranges from 1,900 to 3,600 feet. Average annual precipitation is 10 to 14 inches. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Permeability is moderate, and water-supplying capacity is 8 to 10 inches. Roots penetrate to basalt bedrock at a depth of 20 to 40 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass. Idaho fescue and Sandberg bluegrass are prominent in the stand. Yarrow, lupine, phlox, buckwheat, milkvetch, and other perennial forbs are in the stand. A small amount of shrubs is in some stands. The composition of the original plant community is nearly 100 percent herbaceous species.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 65 percent; Idaho fescue, 20 percent; Sandberg bluegrass, 10 percent; lupine, 2 percent; phlox, 1 percent; yarrow, 1 percent; and other perennial forbs, 1 percent.

Where this site is in poor range condition, big sagebrush and an understory of Sandberg bluegrass commonly dominate the stand. Bluebunch wheatgrass and Idaho fescue have been nearly eliminated. If deterioration is severe, cheatgrass, squirreltail, and annual weeds invade and become dominant.

Most areas of this site are well suited to management. If they are in fair and poor condition, it is practical to spray for control of brush or cheatgrass and to seed grasses. Where a reasonably good stand of perennial grasses is under the brush, spraying alone may be practical.

Where this site is in good to excellent condition, the total annual production of all species is about 900 pounds (air-dry weight) per acre in years of favorable moisture and 450 pounds in dry years. For cattle, herbaceous forage production is estimated at 850 pounds per acre in favorable years and 400 pounds in dry years. Growth of the major forage grasses begins about March 10.

DROUGHTY ROLLING HILLS RANGE SITE

This range site is on McMeen and Tub soils. These are well-drained silt loams; gravelly clay loams; and very stony soils that formed in calcareous colluvium. They are on ridgetops and are moderately sloping on uplands. Elevation ranges from 2,600 to 4,000 feet. Average annual precipitation is 11 to 14 inches. Runoff is medium, and the hazard of erosion is moderate. Permeability is moderately slow to slow, and water-supplying capacity is 6 to 9 inches. Roots penetrate to a depth of 20 to 40 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass. Idaho fescue and Sandberg bluegrass are prominent in the stand. Lupine, milkvetch, phlox, yarrow, and other perennial forbs are in the stand. Small amounts of big sagebrush and rabbitbrush are common, and a few plants of bitterbrush also occur in places. The composition of the original plant community is about 95 percent herbaceous species and 5 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 60 percent; Idaho fescue, 15 percent; Sandberg bluegrass, 5 percent; prairie junegrass, 2 percent; hangingpod milkvetch, 2 percent; lupine, 2 percent; yarrow, 2 percent; phlox, 2 percent; lineleaf fleabane, 2 percent; other perennial forbs, 1 percent; and shrubby species, 7 percent.

Where this site is in poor range condition, Sandberg bluegrass, Thurber needlegrass, and low-value shrubs have nearly replaced the stand of bluebunch wheatgrass and Idaho fescue. If deterioration is severe, snakeweed, cheatgrass, and annual weeds are dominant, and juniper from rocky slopes and ridges can invade the better soil areas and dominate the site.

Some areas of this site are suited to management. If they are in fair or poor condition, it is practical to clear the juniper from the deeper soils or to spray for brush control and then seed grasses. These areas are mapped as Tub gravelly clay loam, 1 to 12 percent slopes, and McMeen silt loam, 1 to 12 percent slopes. Where brush is the problem and a reasonably good stand of grass is under the brush, spraying alone may be the most practical way of returning this site to optimum production.

Where this site is in good to excellent condition, the total annual production of all species is about 800 pounds (air-dry weight) per acre in years of favorable moisture and 400 pounds in dry years. For cattle, herbaceous forage production is estimated at 650 pounds per acre in favorable years and 300 pounds in dry years. Forage production on the shallow, very stony soils and in areas of exposed bedrock is minor, and it generally is desirable to ignore the contribution these areas make toward the forage supply within a pasture. Growth of the major forage grasses begins about March 20.

ARID ROLLING HILLS RANGE SITE

This range site is on Agency and Madras soils. These are well-drained, gently sloping loams that formed in alluvium and colluvium on uplands. Elevation ranges from 2,000 to 3,200 feet. Average annual precipitation is 9 to 12 inches. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Permeability is moderate to moderately slow, and water-supplying capacity is 5 to 7 inches. Roots penetrate to a depth of 20 to 40 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass. Sandberg bluegrass and Thurber needlegrass are prominent in the stand. Indian ricegrass occurs sporadically in small amounts. Buckwheat, phlox, yarrow, fleabane, milkvetch, and other perennial forbs are in the stand. A small amount of big sagebrush and rabbitbrush also occurs in places. The composition of the original plant community is about 90 percent herbaceous species and 10 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 65 percent; Sandberg bluegrass, 10 percent; Thurber needlegrass, 5 percent; Indian ricegrass, 2 percent; phlox, 2 percent; fleabane, 2 percent; buckwheat, 2 percent; yarrow, 1 percent; hangingpod milkvetch, 2 percent; other perennial forbs, 2 percent; big sagebrush, 5 percent; and other shrubby species, 2 percent.

Where this site is in poor range condition, big sagebrush has nearly replaced the stand of bluebunch wheatgrass. Sandberg bluegrass dominates the understory, and such perennial forbs as phlox and fleabane are prominent. If deterioration is severe, cheatgrass and annual weeds replace the perennial forbs and grasses.

This site is well suited to management. Where it is in fair and poor condition, it is practical to control brush and seed drought-resistant grasses. Where a reasonably good stand of perennial grasses is under the brush, spraying alone may be the most practical way of returning this site to optimum condition.

Where this site is in good to excellent condition, the total annual production of all species is about 700 pounds (air-dry weight) per acre in years of favorable moisture and 150 pounds in dry years. For cattle, herbaceous forage production is estimated at 550 pounds per acre in

favorable years and 100 pounds in dry years. Growth of the major forage grasses begins about March 15.

DROUGHTY BOTTOMLAND FAN RANGE SITE

This range site is on Court and Metolius soils. These are well-drained, nearly level to sloping sandy loams that formed in alluvium that is high in content of ash and pumice. They are on alluvial fans and bottom lands. Elevation ranges from 2,000 to 3,000 feet. Average annual precipitation is 9 to 12 inches. Runoff is slow, and the hazard of erosion is slight. Permeability is moderately rapid, and water-supplying capacity is 5 to 7 inches. Roots penetrate to a depth of 20 inches to more than 60 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass, Indian ricegrass, and Thurber needlegrass. Giant wildrye is prominent in the stand in places. Such perennial forbs as yarrow and lupine occur commonly but in minor amounts. A small amount of big sagebrush, rabbitbrush, and bitterbrush also occurs. The composition of the original plant community is about 95 percent herbaceous species and 5 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 55 percent; Indian ricegrass, 10 percent; giant wildrye, 2 percent; Sandberg bluegrass, 5 percent; bottlebrush squirreltail, 2 percent; needle-and-thread, 10 percent; lupine, 2 percent; yarrow, 2 percent; fleabane, 2 percent; phlox, 1 percent; milkvetch, 2 percent; other perennial forbs, 2 percent; and big sagebrush, 5 percent.

Where this site is in poor condition, big sagebrush and gray rabbitbrush have nearly replaced the stand of bluebunch wheatgrass and Indian ricegrass. Such low-value grasses as needle-and-thread and squirreltail are common. If deterioration is severe, cheatgrass and annual weeds invade and the site becomes very brushy and weedy.

This site is well suited to management. If it is in poor to fair condition, it is practical to control brush and seed drought-resistant grasses. Where a reasonably good stand of perennial grasses is under the brush, spraying alone may be the most practical way of returning this site to optimum production.

Where this site is in good to excellent condition, the total annual production of all species is about 700 pounds (air-dry weight) per acre in years of favorable moisture and 500 pounds in dry years. For cattle, herbaceous forage production is estimated at 600 pounds per acre in favorable years and 450 pounds in dry years. Growth of the major forage grasses begins about March 1.

SHRUBBY ROLLING HILLS RANGE SITE

This range site is on Degner, Gribble, Lamonta, and McCoin soils. These are well-drained, gently sloping to moderately steep loams, gravelly loams, and cobbly loams that formed in rhyolite colluvium mixed with loess and residuum derived from sedimentary material. They are on uplands. Elevation ranges from 2,200 to 3,900 feet. Precipitation is 9 to 14 inches. Runoff is medium, and the hazard of erosion is moderate. Permeability is moderate to very slow, and water-supplying capacity is 5 to 8 inches. Roots penetrate to a depth of 10 to 60 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass. Idaho fescue and Sandberg bluegrass are prominent in the stand. Thurber needlegrass occurs sporadically, and such perennial forbs as yarrow, phlox, and lomatium are in the stand. Bitterbrush and a small amount of big sagebrush, rabbitbrush, and wax currant also occur and give the site a shrubby appearance. The composition of the original plant community is about 90 percent herbaceous species and 10 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 55 percent; Idaho fescue, 10 percent; Sandberg bluegrass, 10 percent; Thurber needlegrass, 2 percent; bottlebrush squirreltail, 2 percent; milkvetch, 2 percent; yarrow, 2 percent; phlox, 2 percent; lomatium, 2 percent; other perennial forbs, 1 percent; big sagebrush, 5 percent; antelope bitterbrush, 5 percent; and other shrubby species, 2 percent.

Where this site is in poor range 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 rocky areas may invade the site. If deterioration is severe, low sagebrush and annual weeds invade the areas of shallow and eroded soils.

This site is suited to management. If it is in poor condition, it is practical to clear the juniper or spray for brush control and seed grasses. Where brush is the problem and a reasonably good stand of grass is under the brush, spraying alone may be the most practical way of returning this site to optimum production. Plans for controlling brush should consider the amount and value of existing bitterbrush and other forage shrubs.

Where this site is in good to excellent condition, the total annual production of all species is about 1,000 pounds (air-dry weight) per acre in years of favorable moisture and 600 pounds in dry years. For cattle, herbaceous forage production is estimated at 700 pounds per acre in favorable years and 350 pounds in dry years. Bitterbrush leaves and twigs can provide additional forage and have an annual production of about 75 pounds per acre. Growth of the major forage grasses begins about April 1.

SOUTH EXPOSURE RANGE SITE

This range site is on Prag and Tub soils. These are well-drained very stony loams and cobbly clay loams that formed in loess and mixed colluvium. They have south-facing slopes and are on uplands. Elevation ranges from 2,700 to 4,500 feet. Average annual precipitation is 11 to 16 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Permeability is slow, and water-supplying capacity is 7 to 9 inches. Roots penetrate to a depth of 20 to 40 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass. Sandberg bluegrass is prominent in the stand. Idaho fescue commonly occurs, but in minor amounts. Arrowleaf balsamroot, milkvetch, lupine, buckwheat, and other perennial forbs are in the stand. Bitterbrush and a small amount of big sagebrush and rabbitbrush also occur in places. The composition of the original plant community is about 95 percent herbaceous species and 5 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 75 percent; Idaho fescue, 2 percent; Sandberg bluegrass, 10 percent; Thurber needlegrass, 1 percent; milkvetch, 2 percent; cushion fleabane, 2 percent; longleaf phlox, 2 percent; yarrow, 1 percent; other perennial forbs, 1 percent; antelope bitterbrush, 3 percent; and other shrubby species, 1 percent.

Where this site is in poor range condition, brush cheatgrass and low-value forbs have nearly replaced the stand of forage bunchgrasses. Thurber needlegrass, Sandberg bluegrass, and a few plants of bluebunch wheatgrass occur sporadically. If deterioration is severe, much ground is left bare and juniper, rabbitbrush, and snakeweed can become dominant.

Most areas of this site are suited to management. If they are in poor condition, it is practical to clear the juniper (fig. 12) or spray for brush control and to seed grasses. Where brush is the problem, and a reasonably good stand of grass is under the brush, spraying alone may be the most practical way of returning this site to optimum production.

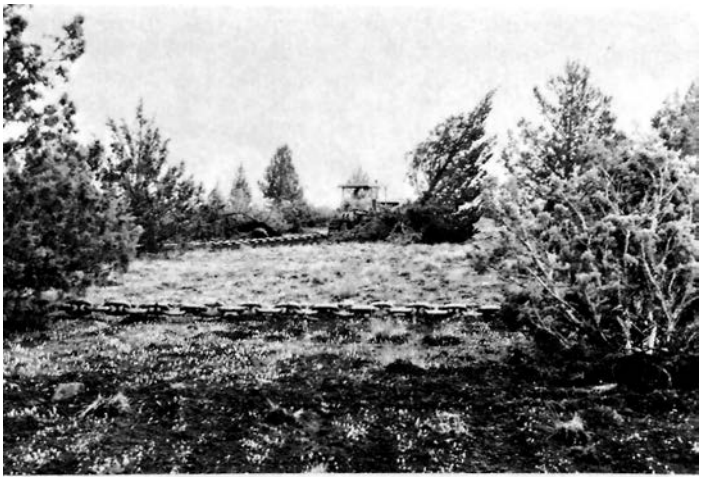

Figure 12.—**Anchor chain being used to clear juniper from an area of Tub cobbly clay loam, 12 to 40 percent slopes.**

Where this site is in good to excellent condition, the total annual production of all species is about 900 pounds (air-dry weight) per acre in years of favorable moisture and 350 pounds in dry years. For cattle, herbaceous forage production is estimated at 700 pounds per acre in favorable years and about 250 pounds in dry years. Bitterbrush leaves and twigs can provide additional forage and have an annual production of about 50 pounds per acre. Growth of the major forage grasses begins about March 15.

STEEP SOUTH RANGE SITE

This range site is on Ginser and Tub soils. These are well-drained, very stony loams and very stony clay loams that formed in loess and mixed colluvium. They have steep, south-facing slopes and are on uplands. Elevation ranges from 2,700 to 4,500 feet. Average annual precipitation is 11 to 16 inches. Runoff is rapid, and the hazard of erosion is severe. Permeability is moderately slow to slow, and water-supplying capacity is 6 to 9 inches. Roots penetrate to a depth of 20 to 40 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass. Sandberg bluegrass is prominent in the stand. Idaho fescue occurs in minor amounts. Arrowleaf balsamroot, buckwheat, lupine, milkvetch, and other perennial forbs are in the stand. Bitterbrush and a number of other shrubs occur in minor amounts. The composition of the original plant community is about 95 percent herbaceous species and 5 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 80 percent; Idaho fescue, 2 percent; Sandberg bluegrass, 5 percent; Thurber needlegrass, 2 percent; arrowleaf balsamroot, 2 percent; lupine, 2 percent; hangingpod milkvetch, 2 percent; other perennial forbs, 1 percent; gray rabbitbrush, 2 percent; and other shrubby species, 2 percent.

Where this site is in poor range condition, big sagebrush, rabbitbrush, juniper, cheatgrass, and low-value forbs have nearly replaced the stand of forage bunchgrasses. If deterioration is severe, erosion exposes the clayey subsoil and much ground is left bare and rocky.

This site generally is not suited to management. Where it is in poor condition, however, it may be practical to spray for brush control on the lower slopes if there is a reasonable stand of grass under the brush.

Where this site is in good to excellent condition, the total anual production of all species is about 800 pounds (air-dry weight) per acre in years of favorable moisture and 150 pounds in dry years. For cattle, herbaceous forage production is estimated at 650 pounds per acre in favorable years and 100 pounds in dry years. Growth of the major forage grasses begins about March 10.

DROUGHTY SOUTH EXPOSURE RANGE SITE

This range site is on Lickskillet, Lithgow, Madras, Simas, and Sorf soils. These are well-drained loams, cobbly silty loams, cobbly loams, and very stony loams that formed in loess and mixed colluvium. They have south-facing slopes and are on uplands. Average annual precipitation is 9 to 14 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Permeability is moderate to slow, and water-supplying capacity is 2.5 to 7.0 inches. Roots penetrate to a depth of 10 to 40 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass. Sandberg bluegrass and Thurber needlegrass are prominent in the stand. Buckwheat, fleabane, milkvetch, phacelia, phlox, and other perennial forbs occur in minor amounts. A small amount of gray rabbitbrush and snakeweed is common. The composition of the original plant community is about 95 percent herbaceous species and 5 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 70 percent; Sandberg bluegrass, 10 percent; Thurber needlegrass, 5 percent; squirreltail, 1 percent; buckwheat, 1 percent; phacelia, 1 percent; yarrow, 1 percent; hangingpod milkvetch, 2 percent; phlox, 1 percent; lupine, 2 percent; big sagebrush, 5 percent; and other shrubby species, 1 percent.

Where this site is in poor range condition, the perennial bunchgrasses have been nearly eliminated. Squirreltail, Thurber needlegrass, and a small amount of bluebunch wheatgrass are in some protected places, such as under brush or in rocky areas. If deterioration is severe, big sagebrush, snakeweed, and juniper become dominant and annual grasses and weeds invade the site.

This site generally is suited to management. If it is in poor condition, it is practical to clear the juniper or spray for brush control and to seed grasses. However, drill seeding on the very stony Lickskillet and Sorf soils is hard on equipment and is not considered practical. Where brush is the problem, and a reasonably good stand of grass is under the brush, spraying alone may be the most practical way of returning this site to optimum production.

Where this site is in good to excellent condition, the total annual production of all species is about 700 pounds (air-dry weight) per acre in years of favorable moisture and 300 pounds in dry years. For cattle, herbaceous forage production is estimated at 600 pounds per acre in favorable years and 250 pounds in dry years. Growth of the major forage grasses begins about March 1.

DROUGHTY STEEP SOUTH RANGE SITE

This range site is on Lickskillet; Lithgow, deep variant; and Simas soils. These are well-drained extremely stony loams, very shaly loams, and very stony clay loams that formed in loess and mixed colluvium. They have steep, south-facing slopes and are on uplands. Elevation ranges from 1,700 to 3,600 feet. Average annual precipitation is 9 to 12 inches. Runoff is rapid, and the hazard of erosion is high. Permeability is slow to moderately rapid, and water-supplying capacity is 2.5 to 7.0 inches. Roots penetrate to a depth of 20 inches to more than 60 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass. Sandberg bluegrass and Thurber needlegrass are prominent in the stand. Arrowleaf balsamroot, lupine, phlox, yarrow, buckwheat, and other perennial forbs are in the stand. Such shrubs as big sagebrush, shadscale, gray rabbitbrush, and bitterbrush occur in minor amounts. The composition of the original plant community is about 95 percent herbaceous species and 5 percent shrubs.

The aproximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 80 percent; Sandberg bluegrass, 10 percent; Thurber needlegrass, 5 percent; arrowleaf balsamroot, 1 percent; lupine, 1 percent; yarrow, 1 percent; and gray rabbitbrush, 2 percent.

Where this site is in poor range 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 ground is left bare and rocky.

This site generally is not suited to management, because the soils are steep, very stony, and very droughty.

Where this site is in good to excellent condition, the total annual production of all species is about 550 pounds (air-dry weight) per acre in years of favorable moisture and 200 pounds in dry years. For cattle, herbaceous forage production is estimated at 500 pounds per acre in favorable years and 150 pounds in dry years. Growth of the major forage grasses begins February 20.

SHRUBBY SOUTH EXPOSURE RANGE SITE

This range site is on Donnybrook and Venator soils. These are well-drained shaly loams and stony loams that formed in loess mixed with colluvium derived from shale, sandstone, and tuffs. They have south-facing slopes and are on uplands. Elevation ranges from 2,500 to 4,500 feet. Average annual precipitation is 11 to 16 inches. Runoff is medium to rapid, and the hazard of erosion is slight to high. Permeability is moderately slow, and water-supplying capacity is 4.0 to 6.5 inches. Depth to fractured bedrock or weathered tuff is 12 to 20 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass. Thurber needlegrass and Sandberg bluegrass are prominent in the stand. Many kinds of perennial forbs grow on this site. Bitterbrush and a number of other shrubs are typically prominent and give the site a shrubby appearance. The composition of the original plant community is about 85 percent herbaceous species and 15 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 60 percent; Idaho fescue, 2 percent; Sandberg bluegrass, 10 percent; Thurber needlegrass, 5 percent; curvepod milkvetch, 2 percent; longleaf phlox, 2 percent; snow buckwheat, 2 percent; lineleaf fleabane, 1 percent; yarrow, 2 percent; antelope bitterbrush, 10 percent; wax currant, 1 percent; gray rabbitbrush, 2 percent; and other shrubby species, 1 percent.

Where this site is in poor range condition, the forage bunchgrasses are low in vigor and widely spaced and matchweed, big sagebrush, and rabbitbrush are prominent. If deterioration is severe, juniper invades and the site becomes brushy and weedy. Bitterbrush and other forage shrubs are hedged, and dead plants occur.

This site is suited to management. If it is in poor condition, it is practical to clear the juniper and seed grasses. Where a reasonable stand of grass is under the brush, spraying for selective control of sage and rabbitbrush may be the most practical way of returning the site to optimum production. Plans for controlling brush should consider the amount and value of existing forage shrubs.

Where this site is in good to excellent condition, the total annual production of all species is about 1,200 pounds (air-dry weight) per acre in years of favorable moisture and 500 pounds in dry years. For cattle, herbaceous forage production is estimated at 800 pounds per acre in favorable years and 250 pounds in dry years. Bitterbrush leaves and twigs can provide additional forage and have an annual production of about 150 pounds per acre. Growth of the major forage grasses begins about March 15.

JUNIPER SOUTH EXPOSURE RANGE SITE

This range site is only on Searles very stony loam, 35 to 65 percent slopes. This soil has a surface layer of very stony loam and a subsoil of very gravelly clay loam. Slopes are 35 to 65 percent. Average annual precipitation is 9 to 12 inches. Permeability is moderate, and water-supplying capacity is 5 to 7 inches. Roots penetrate to a depth of 20 to 40 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass and Thurber

needlegrass. Old-growth juniper occurs where individual trees are widely spaced. Bitterbrush and big sagebrush are common in the stand. Idaho fescue and prairie junegrass also occur in places, but in minor amounts. Perennial forbs are sparse on this site. The composition of the original plant community is about 80 percent herbaceous species, 10 percent shrubs, and 10 percent juniper of all age classes.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 60 percent; Thurber needlegrass, 10 percent; Sandberg bluegrass, 5 percent; annual grasses, 2 percent; phlox, 2 percent; curvepod milkvetch, 2 percent; buckwheat, 2 percent; antelope bitterbrush, 2 percent; big sagebrush, 5 percent; and western juniper, 10 percent.

Where this site is in poor range condition, bluebunch wheatgrass is low in vigor and widely spaced and juniper dominates. Big sagebrush and Thurber needlegrass also are prominent. If deterioration is severe, much ground is left bare and stony and cheatgrass and annual weeds invade.

This site generally is not suited to management, because the soil is steep and stony.

Where this site is in good to excellent condition, the total annual production of all species is about 800 pounds (air-dry weight) per acre in years of favorable moisture and 200 pounds in dry years. For cattle, herbaceous forage production is estimated at 550 pounds per acre in favorable years and 150 pounds in dry years. Bitterbrush leaves and twigs can provide additional forage and have an annual production of about 50 pounds per acre. Growth of the major forage grasses begins about March 1.

NORTH EXPOSURE RANGE SITE

This range site is on Curant, Ginser, Prag, and Tub soils. These are well-drained cobbly loams, gravelly silt loams, and silt loams that formed in tuff and mixed colluvium. Slopes are 5 to 40 percent. Elevation ranges from 2,200 to 4,500 feet. Average annual precipitation is 11 to 16 inches. Runoff is medium, and the hazard of erosion is moderate. Permeability is moderate to slow, and water-supplying capacity is 6 to 10 inches. Roots penetrate to a depth of 20 to 40 inches.

The potential, or climax, plant community of this site is dominated by Idaho fescue where slopes face north and northeast. Bluebunch wheatgrass and Sandberg bluegrass are prominent and dominate some other areas of this site. Yarrow, milkvetch, fleabane, hawkweed, redbell avens, lupine, and other perennial forbs are in the stand. Green rabbitbrush, shrubby buckwheat, wax currant, serviceberry, bitterbrush, and other shrubs commonly occur, but in minor amounts. The composition of the original plant community is nearly 100 percent herbaceous species.

The approximate composition of the climax plant community, by percentage of total weight is Idaho fescue, 60 percent; bluebunch wheatgrass, 20 percent; Sandberg bluegrass, 10 percent; yarrow, 2 percent, Wyeth buckwheat, 1 percent; threadleaf fleabane, 2 percent; stiff milkvetch, 1 percent; lupine, 2 percent; and shrubby species, 2 percent.

Where this site is in poor range condition, the forage bunchgrasses are low in vigor and widely spaced. The mulch layer of lichens and mosses that served to protect the soil surface is destroyed, and bare ground is exposed. Sandberg bluegrass and perennial forbs are prominent in the stand. During the process of deterioration, bluebunch wheatgrass temporarily increases and becomes dominant 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, low sagebrush from adjacent scabland areas invades the stand and the site becomes weedy and brushy.

This site generally is suited to management. If it is in poor condition, and a reasonable stand of grass is under the brush, spraying for brush control may be the most practical way of returning this site to optimum production.

Where this site is in good to excellent condition, the total annual production of all species is about 1,200 pounds (air-dry weight) per acre in years of favorable moisture and 650 pounds in dry years. For cattle, herbaceous forage production is estimated at 1,000 pounds per acre in favorable years and 550 pounds in dry years. Growth of the major forage grasses begins about March 25.

STEEP NORTH RANGE SITE

This range site is on Curant, Ginser, Prag, Tub, and Wrentham soils. These are well-drained silt loams and extremely stony loams that formed in tuff and mixed colluvium. Slopes are 35 to 70 percent. Elevation ranges from 2,200 to 4,500 feet. Average annual precipitation is 10 to 16 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Permeability is slow to moderate, and water-supplying capacity is 6 to 10 inches. Roots penetrate to a depth of 20 inches to more than 60 inches.

The potential, or climax, plant community of this site is dominated by Idaho fescue where slopes north and northeast. Bluebunch wheatgrass and Sandberg bluegrass are prominent, and they dominate some areas of this site. Yarrow, lupine, milkvetch, hawkweed, fleabane, redbell avens, and other perennial forbs are in the stand. Green rabbitbrush, rose, snowberry, wax currant, bitterbrush, and a few other shrubs commonly occur, but in minor amounts. The composition of the original plant community is nearly 100 percent herbaceous species.

The approximate composition of the climax plant community, by percentage of total weight, is Idaho fescue, 70 percent; Cusick bluegrass, 2 percent; bluebunch wheatgrass, 15 percent; Sandberg bluegrass, 5 percent; yarrow, 2 percent; phlox, 1 percent; stiff milkvetch, 1 percent; lupine, 1 percent; other perennial forbs, 1 percent; and shrubby species, 2 percent.

Where this site is in poor range condition, the forage bunchgrasses are low in vigor and widely spaced. The mulch layer of lichens and mosses that served to protect the soil surface has been destroyed, and bare ground is exposed. Sandberg bluegrass and perennial forbs are prominent. During the process of 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, low sagebrush from adjacent scabland areas can invade the stand.

Sagebrush and cheatgrass invade strongly, and the site becomes weedy and brushy.

This site generally is not suited to management. However, if it is in poor condition and a reasonable stand of grass is under the brush, it is practical to spray for brush control on the lower slopes.

Where this site is in good to excellent condition, the total annual production of all species is about 1,000 pounds (air-dry weight) per acre in favorable years and about 700 pounds in dry years. For cattle, herbaceous forage production is estimated at 900 pounds per acre in favorable years and 650 pounds in dry years. Growth of the major forage grasses begins about April 1.

DROUGHTY NORTH EXPOSURE RANGE SITE

This range site is on Simas soils, 8 to 40 percent slopes. These are well-drained silt loams that formed in tuff and loess mixed with colluvial material derived from basalt. They have north-facing slopes of 8 to 40 percent. Elevation ranges from 1,300 to 3,000 feet. Average annual precipitation is 9 to 12 inches. Runoff is medium, and the hazard of erosion is moderate. Permeability is moderate to slow, and the hazard of erosion is moderate. Permeability is moderate to slow, and water-supplying capacity is 6 to 7 inches. Roots penetrate to a depth of 20 inches to more than 60 inches.

The potential, or climax, plant community of this site is dominated by Idaho fescue where slopes face north. Bluebunch wheatgrass is prominent and dominates some areas of this site. Sandberg bluegrass as well as yarrow, fleabane, milkvetch, hawkweed, lupine, and other perennial forbs are in the stand. A few shrubs, such as rabbitbrush, wax currant, and bitterbrush, also occur in places. The composition of the original plant community is about 95 percent herbaceous species and 5 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is Idaho fescue, 30 percent; bluebunch wheatgrass, 45 percent; Sandberg bluegrass, 10 percent; yarrow, 2 percent; lineleaf fleabane, 2 percent; lomatium, 1 percent; stiff milkvetch, 2 percent; broom snakeweed, 1 percent; phlox, 1 percent; antelope bitterbrush, 2 percent; big sagebrush, 2 percent; and other shrubby species, 2 percent.

Where this site is in poor range condition, the forage bunchgrasses are low in vigor and widely spaced. The mulch layer of lichens and mosses that served to protect the soil surface has been destroyed, and bare ground is exposed. During the process of deterioration, bluebunch wheatgrass temporarily increases and becomes dominant 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. Juniper from ridges and rocky outcrops commonly invades severely depleted areas and in places dominates the site.

This site is well suited to management. If it is in poor condition, it is practical to clear the juniper or spray for brush control and to seed grasses. Where brush is the problem and a reasonably good stand of grass is under the brush, spraying alone may be the most practical way of returning this site to optimum production.

Where this site is in good to excellent condition, the total annual production of all species is about 900 pounds (air-dry weight) per acre in years of favorable moisture and 300 pounds in dry years. For cattle, herbaceous forage production is estimated at 800 pounds per acre in favorable years and 250 pounds in dry years. Growth of the major forage grasses begins about March 20.

SHRUBBY NORTH EXPOSURE RANGE SITE

This range site is on Degner and Utley soils. These are well-drained gravelly loams and shaly loams that formed in loess mixed with colluvium derived from shale and tuffaceous material. These soils have north-facing slopes of 10 to 50 percent. Elevation ranges from 2,200 to 4,500 feet. Average annual precipitation is 11 to 16 inches. Runoff is medium, and the hazard of erosion is moderate to high. Permeability is moderate to moderately slow, and water-supplying capacity is 6 to 10 inches. Roots penetrate to a depth of 40 inches to more than 60 inches.

The potential, or climax, plant community of this site is strongly dominated by Idaho fescue. Bluebunch wheatgrass, prairie junegrass, and Sandberg bluegrass are prominent in the stand. Yarrow, buckwheat, lupine, arrowleaf balsamroot, and other perennial forbs are in the stand. Bitterbrush and a variety of other shrubs are prominent and give the site a shrubby appearance. The composition of the original plant community is about 80 percent herbaceous species and 20 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is Idaho fescue, 45 percent; bluebunch wheatgrass, 15 percent; Sandberg bluegrass, 10 percent; prairie junegrass, 2 percent; lineleaf fleabane, 1 percent; buckwheat, 1 percent; hangingpod milkvetch, 2 percent; yarrow, 1 percent; phlox, 2 percent; other perennial forbs, 1 percent; big sagebrush, 2 percent; antelope bitterbrush, 15 percent; green rabbitbrush, 2 percent; and other shrubby species, 1 percent.

Where this site is in poor range condition, Idaho fescue and bluebunch wheatgrass are low in vigor and widely spaced. During the process of deterioration, bluebunch wheatgrass temporarily increases and becomes dominant 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 forage bunchgrasses are nearly eliminated, the site becomes brushy and weedy, and in places juniper invades. Forage shrubs are commonly hedged, and dead plants occur.

This site is suited to management. If it is in poor condition and a reasonable stand of perennial grasses is under the brush, it is practical to spray for selective control of sage and rabbitbrush. Plans for controlling brush should consider the amount and value of existing bitterbrush and other forage shrubs and the risk of damaging these plants.

Where this site is in good to excellent condition, the total annual production of all species is about 1,500 pounds (air-dry weight) per acre in years of favorable moisture and 800 pounds in dry years. For cattle, herbaceous forage production is estimated at 850 pounds per acre in favorable years and 400 pounds in dry years. Bitterbrush leaves and twigs can provide additional

forage and have an annual production of about 200 pounds per acre. Growth of the major forage grasses begins about April 5.

SAND HILLS RANGE SITE

This range site is only on Era soils, 1 to 8 percent slopes. These are somewhat excessively drained soils that have a surface layer and subsoil of loam to stony loam. They formed in eolian deposits high in content of ash and pumice. Elevation ranges from 2,000 to 3,000 feet. Average annual precipitation is 9 to 12 inches. Runoff is slow, and the hazard of erosion is slight, and the hazard of soil blowing is moderate. Permeability is moderately rapid, and water-supplying capacity is 6 to 7 inches. Roots penetrate to a depth of 40 to 60 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass. Thurber needlegrass, Indian ricegrass, and Sandberg bluegrass are prominent in the stand. Needle-and-thread and prairie junegrass occur, but in minor amounts. Giant wildrye is in spots, such as depressional areas. Milkvetch, yarrow, lupine, fleabane, phlox, and other perennial forbs are in the stand. Gray rabbitbrush and big sagebrush are common, and a small amount of bitterbrush is in places. The composition of the original plant community is about 90 percent herbaceous species and 10 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 60 percent; Indian ricegrass, 10 percent; Thurber needlegrass, 5 percent; Sandberg bluegrass, 5 percent; prairie junegrass, 2 percent; hangingpod milkvetch, 3 percent; lupine, 5 percent; yarrow, 2 percent; buckwheat, 2 percent; big sagebrush, 5 percent; and gray rabbitbrush, 1 percent.

Where this site is in poor range condition, big sagebrush has nearly replaced the stand of tall bunchgrasses. As the condition further deteriorates, squirreltail grass, cheatgrass, broom snakeweed, and annual forbs invade and much ground is left bare.

This site is well suited to management. If it is in poor condition, it is practical to spray for brush control and to seed grasses. Where a reasonably good stand of grass is under the brush, spraying alone may be the most practical way of returning this site to optimum production.

Where this site is in good to excellent condition, the total annual production of all species is about 750 pounds (air-dry weight) per acre in years of favorable moisture and 550 pounds in dry years. For cattle, herbaceous forage production is estimated at 600 pounds per acre in favorable years and 400 pounds in dry years. Growth of major forage grasses begins about March 1.

SANDY NORTH EXPOSURE RANGE SITE

This range site is only on Era soils, 8 to 40 percent slopes. These are somewhat excessively drained soils that have a surface layer and subsoil of loam to stony loam. They formed in eolian deposits that are high in content of ash and pumice. Elevation ranges from 2,000 to 3,000 feet. Average annual precipitation is 9 to 12 inches. Runoff is medium, and the hazard of erosion is moderate. Permeability is moderately rapid, and water-supplying capacity is 6 to 7 inches. Roots penetrate to a depth of 40 to 60 inches.

The potential, or climax, plant community of this site is dominated by Idaho fescue. Bluebunch wheatgrass, big bluegrass, and Sandberg bluegrass are prominent in the stand. Balsamroot, buckwheat, phacelia, yarrow, and other perennial forbs are in the stand. Bitterbrush, big sagebrush, and rabbitbrush are prominent and give the site a shrubby appearance. The composition of the original plant community is about 85 percent herbaceous species and 15 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is Idaho fescue, 45 percent; bluebunch wheatgrass, 15 percent; big bluegrass, 5 percent; Sandberg bluegrass, 5 percent; needle-and-thread, 2 percent; prairie junegrass, 5 percent; Carey balsamroot, 2 percent; buckwheat, 5 percent, yarrow, 1 percent; green rabbitbrush, 5 percent; and antelope bitterbrush, 10 percent.

Where this site is in poor range condition, big sagebrush and rabbitbrush dominate the stand. Such low-value grasses as needle-and-thread and squirreltail are common. If deterioration is severe, the site is very brushy and weedy.

The site is well suited to management. If it is in poor condition, it is practical to spray for brush control and seed grasses. Where a reasonably good stand of grass is under the brush, spraying alone may be the most practical way of returning this site to optimum production.

Where this site is in good to excellent condition, the total annual production of all species is about 1,600 pounds (air-dry weight) per acre in years of favorable moisture and 1,200 pounds in dry years. For cattle, herbaceous forage production is estimated at 1,000 pounds per acre in favorable years and 700 pounds in dry years. Bitterbrush leaves and twigs can provide additional forage and have an annual production of about 150 pounds per acre. Growth of the major forage grasses begins about March 15.

SCABLAND RANGE SITE

This range site is only on Bakeoven very cobbly loam, 2 to 20 percent slopes. This is a well-drained soil that has a surface layer of very cobbly loam and a subsoil of very gravelly heavy loam. It formed in loess and residuum weathered from basalt. It is on uplands. Elevation ranges from 1,600 to 3,600 feet. Average annual precipitation is 10 to 14 inches. Runoff is slow to rapid, and the hazard of erosion is slight to moderate. Permeability is moderately slow, and water-supplying capacity is less than 2.5 inches. Roots penetrate to a depth of 4 to 12 inches.

The potential, or climax, plant community of this site is dominated by Sandberg bluegrass and stiff sagebrush. Phlox, buckwheat, scab balsamroot, and other perennial forbs are in the stand. The composition of the original plant community is about 25 percent herbaceous species and 75 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is Sandberg bluegrass, 20 percent; squirreltail, 1 percent; snow buckwheat, 1 percent; serrated balsamroot, 1 percent; tapertip onion, 1 percent; bigseed lomatium, 1 percent; and stiff sagebrush, 75 percent.

Where this site is in poor range condition, the already sparse stand of bluebunch wheatgrass and other bunchgrasses has been nearly eliminated. Sandberg bluegrass is depleted, and stiff sagebrush and forbs have increased. If deterioration is severe, only hedged sagebrush occupies the site.

This site generally is not suited to management. 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 in areas of this site if possible.

Where this site is in good to excellent condition, the total annual production of all species is about 400 pounds (air-dry weight) per acre in years of favorable moisture. For a short period of time in spring and fall, production of herbaceous forage for cattle is estimated at 150 pounds per acre. Stiff sagebrush leaves and twigs can provide additional forage in fall and winter and have an annual production of about 200 pounds per acre. Growth of the major forage grasses begins about April 5.

BISCUIT-SCABLAND COMPLEX RANGE SITE

This complex range site consists of two range sites that occur in a distinctive pattern of circular mounds, or biscuits, surrounded by scabland. These areas are not practical to separate. The biscuit part consists of Condon soils and makes up 10 to 35 percent of the site. The scabland part consists of Bakeoven soils and makes up 50 to 85 percent of the site where it is mapped as Bakeoven-Condon complex, 2 to 20 percent slopes. These proportions are reversed in the part of the site mapped as Condon-Bakeoven complex, 2 to 20 percent slopes. These soils are on broad ridgetops and have slopes of 2 to 20 percent. They are mainly in the northern part of the survey area. Elevation ranges from 1,600 to 3,600 feet. Average annual precipitation is 10 to 14 inches. Runoff is slow to rapid, and the hazard of erosion is slight to moderate. The Condon soils that occupy the biscuits formed in loess and are 20 to 40 inches deep over basalt bedrock. Permeability is moderate, and water-supplying capacity is 6 to 8 inches. The Bakeoven soils that occupy the scablands are 4 to 12 inches deep and are very cobbly loam. Their water-supplying capacity is less than 2.5 inches.

The composition of the potential, or climax, plant community on the biscuits is nearly 100 percent herbaceous species. Bluebunch wheatgrass is dominant. Idaho fescue is prominent on the northside of the biscuits. Sandberg bluegrass and several kinds of perennial forbs are in the stand. In areas of scabland a composition of stiff sagebrush and Sandberg bluegrass dominates.

The approximate composition of the complex plant community on the biscuits, by percentage of total weight, is bluebunch wheatgrass, 65 percent; Idaho fescue, 15 percent; Sandberg bluegrass, 10 percent; lupine, 2 percent; yarrow, 2 percent; fleabane, 2 percent; phlox, 2 percent; and other perennial forbs, 2 percent.

The approximate composition of the climax plant community on the scabland, by percentage of total weight, is Sandberg bluegrass, 20 percent; squirreltail, 1 percent; fleabane, 1 percent; phlox, 1 percent; buckwheat, 2 percent; and stiff sagebrush, 75 percent.

Where this site is in poor range condition, the perennial bunchgrasses have been nearly eliminated. Big sagebrush, rabbitbrush, cheatgrass, and annual weeds invade, and the biscuits become brushy and weedy. When the site is in this condition, only hedged sagebrush occupies the interspersed scabland areas.

The biscuits in this site are generally suited to management. If they are in poor condition, brush eradication and seeding are practical, but it is essential to take into account the total area that is actually covered by biscuits. Also, the scablands commonly hinder the movement of equipment from one biscuit to another. Where a reasonably good stand of grass is under the brush, spraying alone may be the most practical way of returning this site to optimum production.

Where the biscuit part of this site is in good to excellent condition, the total annual production of all species is about 1,300 pounds (air-dry weight) per acre in years of favorable moisture and 800 pounds in dry years. For cattle, herbaceous forage production on the biscuits is estimated at 1,200 pounds per acre in favorable years and 650 pounds in dry years. In the scabland areas the forage production is generally low, and it is most practical to ignore the forage production because of markedly different season of use and short period of availability. Growth of the major forage grasses begins about March 15.

ADOBELAND RANGE SITE

This range site is only on Day clay, 8 to 40 percent slopes. This is a well-drained soil. Elevation ranges from 1,300 to 3,500 feet. Average annual precipitation is 9 to 14 inches. Runoff is slow until the soil becomes saturated, and then runoff is rapid and the hazard of erosion is high. Permeability is very slow, and water-supplying capacity is 6 to 8 inches. Roots penetrate to a depth of 40 to 60 inches.

The potential, or climax, plant community of this site is dominated by bluebunch wheatgrass. Phlox, yarrow, buckwheat, pussytoes, and other perennial forbs are in the stand. A small amount of giant wildrye, big sagebrush, and rabbitbrush also occurs in places. The composition of the original plant community is nearly 100 percent herbaceous species.

The approximate composition of the climax plant community, by percentage of total weight, is bluebunch wheatgrass, 75 percent; Idaho fescue, 2 percent; Sandberg bluegrass, 10 percent; mountain brome, 2 percent; carrotleaf lomatium, 2 percent; yarrow, 2 percent; buckwheat, 2 percent; phlox, 2 percent; gray rabbitbrush, 2 percent; and other shrubby species, 1 percent.

Where this site is in poor range condition, low-value shrubs, annual grasses, and weeds have nearly replaced the stand of bluebunch wheatgrass and Idaho fescue. Mountain brome and soft chess commonly dominate the stand. If deterioration is severe, the site becomes barren and eroded.

This site is poorly suited to management because of drastic swelling and shrinking of the soil on wetting and drying. This high expansion and contraction makes seedling establishment difficult for the slower developing perennial grasses. Where this site is in poor condition and a reasonable stand of grass is under the brush, spraying for brush control may be the most practical way of returning this site to optimum production.

Where this site is in good to excellent condition, the total annual production of all species is about 700 pounds

(air-dry weight) per acre in years of favorable moisture and 300 pounds in dry years. For cattle, herbaceous forage production is estimated at 600 pounds per acre in favorable years and 250 pounds in dry years. Growth of the major forage grasses begins about March 1.

MOIST BOTTOM RANGE SITE

This range site is only on Willowdale loam. This is a well-drained soil that is loam throughout. It formed in alluvium mixed with volcanic ash. This soil occupies bottom lands, and slopes are 0 to 2 percent. Elevation ranges from 1,400 to 3,000 feet. Average annual precipitation is 9 to 12 inches. Runoff is slow, and the hazard of erosion generally is slight, but the soil is subject to flooding and the hazard of erosion by streams is high in places. Permeability is moderate, and water-supplying capacity is 6 to 7 inches. Roots penetrate to a depth of 40 inches to more than 60 inches.

The potential, or climax, plant community of this site is dominated by giant wildrye. Idaho fescue, big bluegrass, bluebunch wheatgrass, and Kentucky bluegrass are prominent in the stand. Many other kinds of perennial grasses and grasslike plants occur, but in minor amounts. Many kinds of perennial forbs and a few shrubs also occur in minor amounts. The composition of the original plant community is about 95 percent herbaceous species and 5 percent shrubs.

The approximate composition of the climax plant community, by percentage of total weight, is giant wildrye, 75 percent; big bluegrass, 5 percent; Idaho fescue, 5 percent; Kentucky bluegrass, 5 percent, sedge, 2 percent; yarrow, 1 percent; lupine, 2 percent; cinquefoil, 2 percent; rose, 1 percent; and big sagebrush, 2 percent.

Where this site is in poor range condition, big sagebrush and rabbitbrush have nearly replaced the stand of giant wildrye. If deterioration is severe, the site becomes very brushy and much ground is left bare under the brush.

In the absence of severe erosion disturbance, this site is very well suited to special improvement measures. Where it is in fair and poor condition, it is practical to clear the brush and seed grasses.

Where this site is in good to excellent condition, the total annual production of all species is about 3,800 pounds (air-dry weight) per acre in years of favorable moisture and 2,000 pounds in dry years. For cattle, herbaceous forage production is estimated at 3,500 pounds per acre in favorable years and 1,800 pounds in dry years. Growth of the major forage grasses begins about March 20.

MOIST ALKALINE BOTTOM RANGE SITE

This range site is only on Rail clay. This is a somewhat poorly drained soil that is clay throughout. It has slopes of 0 to 2 percent and occurs along streams. Elevation ranges from 1,700 to 3,000 feet. Average annual precipitation is 10 to 14 inches. The site receives additional moisture as seepage and runoff from adjacent uplands. Runoff is slow. The hazard of erosion generally is slight, but it is high in places by streams. Permeability is very slow, and water-supplying capacity is 6.5 to 9.0 inches. Roots penetrate to a depth of 40 inches to more than 60 inches.

The potential, or climax, plant community of this site is dominated by giant wildrye. Creeping wildrye and quackgrass are prominent in the stand. Bunchgrasses, such as bluebunch wheatgrass and Idaho fescue, are common, but they occur in minor amounts. Perennial forbs and a few shrubs also occur in minor amounts in places. The composition of the original plant community is nearly 100 percent herbaceous species.

The approximate composition of the climax plant community, by percentage of total weight, is giant wildrye, 70 percent; Idaho fescue, 5 percent; quackgrass, 10 percent; creeping wildrye, 10 percent; yarrow, 1 percent; goldenrod, 2 percent; tall green rabbitbrush, 1 percent; and willow, 1 percent.

Where this site is in poor range condition, such sod-formers as quackgrass and creeping wildrye have nearly replaced the stand of giant wildrye. If deterioration is severe, cheatgrass, annual weeds, and big sagebrush invade and dominate the site, much ground is left bare, and streambanks erode readily.

This site is well suited to management. Although the soils are naturally somewhat poorly drained, well-drained areas occur where watercourses have incised the flood plain. Where this site is in fair and poor condition, it is practical to spray for brush control and seed suited grasses.

Where this site is in good to excellent condition, the total annual production of all species is about 5,500 pounds (air-dry weight) per acre in years of favorable moisture and 3,000 pounds per acre in dry years. For cattle, herbaceous forage production is estimated at 5,000 pounds per acre in favorable years and 3,500 pounds in dry years. Growth of the major forage grasses begins about March 20.

SEMI-WET BOTTOM RANGE SITE

This range site is only on Mixed alluvial land. This land type is typically well drained, but some areas at the higher elevations have a seasonal high water table. It consists of intermingled clay loams, silty clay loams, loams, and sandy loams on stream bottoms and alluvial fans. Elevation ranges from 1,400 to 4,500 feet. Average annual precipitation is 9 to 25 inches. Permeability is moderately rapid to slow. Runoff is slow. The hazard of erosion generally is slight. On the soils that are subject to flooding, however, the hazard of erosion by streams is high in places. Roots penetrate to a depth of 20 inches to more than 60 inches.

The potential, or complex, plant community of this site consists of a dense stand of perennial grasses and forbs under an open stand of tall shrubs and aspen trees. Ponderosa pine grows in the mountainous areas of this site. Such grasses as redtop, meadow fescue, and Kentucky bluegrass are prominent in the stand. Cow clover, western aster, cinquefoil, Rocky Mountain iris, yarrow, and other perennial forbs are in the stand. The composition of the original plant community is about 90 percent herbaceous species and 10 percent shrubs and trees.

The approximate composition of the climax plant community, by percentage of total weight, is redtop, 25 percent; slender wheatgrass, 5 percent; meadow fescue, 10 percent; tufted hairgrass, 5 percent; cow clover, 10 percent; Kentucky bluegrass, 10 percent; sedge, 10 percent; timothy, 10 percent; cinquefoil, 5 percent;

plantain, 1 percent; golden currant, 1 percent; snowberry, 2 percent; cottonwood reproduction, 5 percent; and aspen, 1 percent.

Where this site is in poor range condition, the sod cover is broken and the forage grasses are low in vigor. If deterioration is severe, much ground is left bare and the site becomes brushy and weedy. The site is subject to damaging overflow, and under these conditions the streambanks erode readily.

This site is poorly suited to management because it generally is subject to damaging floodwaters. However, in places it is practical to use mechanical brush control and to seed grasses in disturbed soil areas. Chemical brush control should be avoided on this site because there are desirable shrubs and trees that are valuable for wildlife habitat, recreation, and other uses.

Where this site is in good to excellent condition, the total annual production of all species is about 2,500 pounds (air-dry weight) per acre. For cattle, forage production is estimated at 2,100 pounds. Growth of the major forage grasses begins about April 5.

PINE–BUNCHGRASS RANGE SITE

This range site is only on Hankins cobbly loam, 15 to 50 percent slopes. This is a well-drained soil that has a surface layer of cobbly loam and a subsoil of cobbly clay. It is on uplands. Elevation ranges from 3,500 to 5,000 feet. Average annual precipitation is 16 to 25 inches. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Permeability is slow, and water-supplying capacity is 10 to 15 inches. Roots penetrate to a depth of 40 to 60 inches.

This site is a ponderosa pine woodland community. The understory is dominated by Idaho fescue and bluebunch wheatgrass. Many kinds of perennial forbs and other perennial grasses are in the stand. Bitterbrush and mountain snowberry are dominant shrubs, and many other kinds of shrubs are common. There is an occasional Douglas-fir in the overstory in the more favorable spots. In moderately stocked, mixed-age stands, the tree canopy is about 40 percent.

As the understory deteriorates, the forage bunchgrasses lose vigor and decrease and perennial forbs become prominent in the stand. Severe deterioration results in domination of the understory by annual grasses, forbs, and low-value shrubs. This condition commonly results in dense clumps of pine that reduce the quality of grazing of the site.

The approximate composition of the climax plant community, by percentage of total weight, is Idaho fescue, 50 percent; bluebunch wheatgrass, 15 percent; Sandberg bluegrass, 5 percent; prairie junegrass, 2 percent; Woollyweed, 2 percent; American vetch, 2 percent; arrowleaf balsamroot, 5 percent; lupine, 2 percent; strawberry, 2 percent; yarrow, 2 percent; other forbs, 3 percent; antelope bitterbrush, 2 percent; common snowberry, 3 percent; wax currant, 1 percent; low Oregon grape, 1 percent; rose, 1 percent; and ponderosa pine reproduction, 2 percent.

Idaho fescue and bluebunch wheatgrass are the major forage-producing plants on this site. The estimated initial stocking rate, in acres per animal-unit-month, for a canopy cover of 10 to 40 percent is 2 to 4 where the site is in excellent condition, 3 to 7 where the site is in good condition, 6 to 12 where the site is in fair condition, and 8 to 20 where the site is in poor condition.

Where this site has been cut over or burned, it is suited to management. It is practical to broadcast seed of suited plants in ashes following fire and in disturbed areas following logging before fall rain settles the seedbed. A major objective of seeding is to stabilize the soil. This site also provides important forage and cover for deer and elk, which should be taken into account when planning management. Growth of the major forage grasses begins about April 1.

MIXED FIR-PINE FOREST RANGE SITE

This range site is on Boardtree and Yawkey soils. These are well-drained gravelly loams. They have slopes of 20 to 70 percent and are on uplands. Elevation ranges from 3,500 to 5,000 feet. Average annual precipitation is 16 to 25 inches. Runoff is rapid, and the hazard of erosion is high. Permeability is moderately slow to very slow, and water-supplying capacity is 8 to 20 inches. Roots penetrate to a depth of 40 inches to more than 60 inches.

This site is a forest community of Douglas-fir and ponderosa pine, which occur in variable amounts. The understory is dominated by elk sedge, and Idaho fescue and pinegrass are prominent in the stand. Many other kinds of perennial grasses commonly occur, along with a sparse stand of shade-tolerant forbs and shrubs. Grand fir occurs in minor amounts in places. In moderately stocked, mixed-age-class stands, the tree canopy is about 40 to 70 percent.

As the understory deteriorates, elk sedge and other forage bunchgrasses lose vigor and decrease in the stand. If deterioration is severe, the site can become weedy and brushy and in places has low-value shrubs and thickets of tree reproduction. In some densely shaded areas the understory consists of no more than a few scattered forbs and an occasional spear of grass.

In the following paragraphs, the principal understory species in this site are named according to their value for grazing by cattle.

High value for grazing.—Plants that generally decrease under heavy grazing. These plants are elk sedge, Idaho fescue, big bluegrass, mountain brome, timothy, woollyweed, vetch, bitterbrush, and willow.

Medium or indefinite value for grazing.—Plants that can temporarily increase but then decrease under heavy grazing. The plants are Kentucky bluegrass, Wheeler bluegrass, prairie junegrass, pinegrass, heartleaf arnica, lupine, strawberry, yarrow, Oregon grape, rose, common snowberry, and spirea.

Low value for grazing.—Plants, including annuals, that continue to increase under heavy grazing. These plants are cheatgrass brome, squirreltail, bull thistle, sedum, gumweed, and gray rabbitbrush.

Forage production under forest cover on this site generally is minor. In open-grown stands the major forage-producing plants are elk sedge, Idaho fescue, and pinegrass. Forage on this site commonly is green and has high nutritional value as compared to dry forage on adjacent sites. The estimated initial stocking rate, in acres per animal-unit-month, for a canopy cover of 40 to 70 percent is 2 to 3 where the site is in excellent condition, 2 to 5 where the site is in good condition, 4 to

10 where the site is in fair condition, and 8 to 15 where the site is in poor condition.

Where this site has been cut over or burned, it is suited to special forage management. It can produce a considerable amount of forage for a number of years under proper management. After fire or logging, it is practical to broadcast seed of suited plants in disturbed areas before fall rain settles the seedbed. A major objective of seeding is to stabilize the soil. This site also provides important forage and cover for deer and elk, which should be taken into account when planning management. Growth of the major forage grasses begins about May 1.

Woodland [4]

Conifer forests occur along the fringe of the Ochoco Mountains in the southeastern part of the survey area and make up about 6 percent of the total acreage. On the south-facing slopes is predominantly ponderosa pine, and on the north-facing slopes is a mixture of Douglas-fir and ponderosa pine. Juniper occurs throughout the rest of the survey area.

Past logging operations have removed a large part of the original stand of timber. Second-growth stands are dominant. Both grazing and logging have been practiced in recent years in timbered areas. The logged areas have provided a source of livestock feed in summer. Grazing values are reduced as the trees begin to shade the grasses.

Woodland suitability groups

Management of woodland can be planned more effectively if the soils are grouped according to those characteristics that affect the survival and growth of various kinds of trees. For this reason, the soils of the Trout Creek-Shaniko Area that are used for woodland or grazable woodland have been placed in woodland suitability groups. Each group consists of soils that have about the same suitability for wood crops, require about the same management, and have similar potential productivity. These groups are based on woodland suitability class, as shown in table 3, and are divided into woodland suitability subclasses to express soil properties associated with significant hazards, restrictions, or limitations for woodland use and management.

In each woodland suitability group, the characteristics of the soils are described first. Then information about suitable trees is given, followed by the estimated production potential in terms of site index. Ratings for certain hazards and limitations that affect management are also shown.

In the paragraphs that follow, an explanation of site index and of the ratings of management hazards and limitations is given. Then each woodland group in the survey area is described.

The potential productivity of a soil is expressed as the site index (*9*). Site index is the height, in feet, that a specified kind of tree will reach in 100 years. It reflects the capacity of a soil to supply moisture and to provide growing space for tree roots. Site indexes can be used to estimate production, as in table 4. The site index ratings are based on field measurements and are subject to refinement as more data are obtained.

Plant competition.—If openings are made in the woodland canopy, grasses, sedges, and shrubs invade. The invading growth competes with trees and hinders their establishment and growth.

Competition is *slight* if it does not prevent adequate natural regeneration or growth of seedlings. It is *moderate* if the invaders delay natural or artificial regeneration but do not prevent the eventual development of fully stocked normal stands. Competition is *high* if trees cannot regenerate naturally or artificially without special treatment.

Equipment limitations.—Drainage, slope, erosion, number or size of stones, soil texture, or other soil characteristics can restrict or prohibit the use of ordinary equipment for planting or harvesting. The limitation is *slight* if there are no restrictions on the type of equipment that can be used. It is *moderate* if slope, soil texture, or wetness in winter and early in spring restricts the use of heavy equipment. The equipment limitation is *high* if only a few types of equipment can be used, if the period during which equipment cannot be used is more than 3 months each year, and if the use of equipment severely damages the roots of trees and the structure and stability of the soil. The limitations are high on steeply sloping soils, soils that have rock outcrops, and soils that have clayey texture.

Hazard of erosion.—The degree of erosion of a soil can affect the growth and development of a stand of trees. A high hazard of erosion requires special practices in places, even for limited production. Woodland soils can be protected from erosion by using special techniques in management and by carefully constructing and maintaining roads, trails, and landings.

The hazard of erosion is rated according to the risk of erosion on woodland soils that are not protected by special practices. It is *slight* where only a small loss of soil is expected. The hazard of erosion is *moderate* where a moderate loss of soil is expected if runoff is not controlled. It is *high* where steep slope, rapid runoff, slow infiltration, and slow permeability make the soil highly susceptible to erosion.

Seedling mortality.—Even when healthy seedlings of a suitable kind of tree are correctly planted or occur

TABLE 3.—*Woodland suitability class for ponderosa pine*

[The symbol > means more than, the symbol < means less than]

Woodland suitability class	Site index	
	Central value	Range
1	120	>112
2	106	99–112
3	92	85–98
4	78	71–84
5	64	57–70
6	50	43–56
7	36	<43

[4] R. E HARTUNG, woodland conservationist, Soil Conservation Service, helped to prepare this section.

TABLE 4.—*Board-foot volume per acre for even-aged stands of ponderosa pine, by site index* [1]

[International rule, trees 6.6 inches and more in diameter at breast height]

Age of trees	Volume per acre, by site index			
	50	60	70	80
	Board feet	*Board feet*	*Board feet*	*Board feet*
40		500	1, 900	3, 700
60	1, 500	3, 700	7, 600	12, 600
80	4, 900	8, 800	15, 000	23, 100
100	9, 200	14, 600	22, 000	31, 200

[1] To 6-inch top inside bark, exclusive of 2-foot stump, measured to nearest 100 board feet.

naturally in adequate numbers, some of them do not survive if the characteristics of the soil are unfavorable.

Mortality is *slight* if 25 percent or less of the seedlings die or if trees regenerate naturally in places where an adequate source of seeds is available. It is *moderate* if 25 to 50 percent of the seedlings die or if trees do not regenerate naturally in numbers needed for adequate restocking. Mortality is *high* if more than 50 percent of the planted seedlings die or if the trees ordinarily do not reseed naturally.

WOODLAND SUITABILITY GROUP 4r

This group consists of Boardtree and Yawkey gravelly loams, 20 to 70 percent slopes. These are well-drained soils that formed in volcanic ash over clay and basalt colluvium. They are moderately steep to steep soils on uplands. Elevation ranges from 3,500 to 5,000 feet. Average annual precipitation ranges from 16 to 25 inches, and average annual air temperature ranges from 40° to 45° F. The frost-free period is 10 to 50 days at 32° and 80 to 100 days at 28°.

The dominant tree on this woodland group is Douglas-fir. Ponderosa pine accounts for about 10 to 15 percent of the stand. Western larch and grand fir occur in places at an elevation of 4,500 feet or higher.

The site index rating for Douglas-fir on the Boardtree soil averages 75 but ranges from 71 to 79 where slopes are less than 30 percent. Where slopes are more than 30 percent, the index averages 89 but ranges from 87 to 92. The site index for Douglas-fir on the Yawkey soil averages 76 but ranges from 70 to 82. The site index for ponderosa pine on the Boardtree soil averages 76 but ranges from 72 to 80. On the Yawkey soil, the estimated site index rating for ponderosa pine ranges from 60 to 70.

The hazard of erosion is high. Precautions need to be taken to avoid excessive damage. Equipment limitations are high. Snow cover can occur over an extended period of time. Steep slopes or rock outcrops hinder logging operations in some areas. Seedling mortality is slight. Plant competition is moderate, but grasses and forbs tend to invade disturbed areas.

WOODLAND SUITABILITY GROUP 5c

This group consists only of Hankins cobbly loam, 15 to 50 percent slopes. This is a well-drained soil that has a surface layer of cobbly loam and a subsoil of cobbly clay. It formed in colluvium that is mixed with ash in the upper part and is underlain by clay. It is a moderately steep to steep soil on uplands. Elevation ranges from 3,500 to 5,000 feet. Average annual precipitation ranges from 16 to 25 inches, and average annual air temperature ranges from 40° to 45° F. The frost-free period is 20 to 60 days at 32° and 90 to 110 days at 28°.

The common tree on this woodland group is ponderosa pine. Small amounts of Douglas-fir and some juniper also are in the stand. Timber stands commonly are scattered and clumpy.

The site index rating for ponderosa pine averages 63 but ranges from 60 to 66. The site index for Douglas-fir averages 73 but ranges from 71 to 75.

The hazard of erosion is moderate where slopes are 15 to 30 percent and high where slopes are steeper. Equipment limitations are high. The soil becomes plastic and has limited trafficability when wet. Soil structure is affected if the soil is disturbed in a wet condition. Snow cover can occur over an extended period of time. Seedling mortality is moderate. Plant competition is slight, but in places grass competes with tree seedlings in dry years.

Wildlife and Fish [5]

Most soils of the Trout Creek-Shaniko Area are suited to and support one or more species of wildlife. The distribution of species is dependent on many environmental factors. Of major importance is the availability of an adequate water and food supply for year-round use. Some soils, such as the Condon soils, produce large quantities of grasses but do not have the shrubs necessary to provide good habitat for mule deer. Such soils as the Utley soils produce large quantities of bitterbrush and other shrubs, making very desirable habitat for mule deer. Other major factors that affect wildlife distribution within the area are elevation, topography, and the amount of snow cover in winter. Soils of the area, as well as impounded water, are mostly neutral to moderately alkaline in reaction. This range of reaction provides excellent medium for growth of fish.

Mule deer are common throughout the Area, and few Rocky Mountain Elk can be seen late in fall and during winter in the timbered southeastern part of the survey area. Chukar partridge, California quail, mountain quail, Hungarian partridge, and mourning dove are throughout the area. Ring-necked pheasants and waterfowl are prevalent along the narrow bottom lands. Muskrats, beaver, otter, mink, and other furbearers inhabit the larger streams and are near ponds. Coyotes, porcupines, badgers, skunks, raccoons, bobcats, squirrels, mice, hawks, owls, magpies, ravens, eagles, and other nongame species also are throughout the Area.

Wildlife groups

Soils are an important part of the total environment that determines the production and distribution of

[5] R. A. CORTHELL, biologist, Soil Conservation Service, assisted in the preparation of this section.

various levels of wildlife populations. Other important factors include year-round food supply, water, cover, and climate.

In the following paragraphs, soils that have similar characteristics for wildlife production have been combined into wildlife groups. These groups are briefly described as they relate to the various kinds of wildlife. The texture given for the soils is that of the surface layer, unless otherwise noted. The soils in each group can be determined by referring to the "Guide to Mapping Units" at the back of this survey.

WILDLIFE GROUP 1

This group consists of well-drained silt loams to extremely stony loams that formed in loess and mixed colluvium. These soils are gently sloping on broad ridgetops and steep to very steep on the sides of canyons on upland plateaus. The native vegetation is grasses, forbs, and shrubs. Elevation ranges from 1,000 to 3,600 feet. Average annual precipitation ranges from 10 to 14 inches, average annual air temperature ranges from 45 to 52° F., and the frost-free period is 50 to 150 days at 32° and 100 to 170 days at 28°.

Mule deer are common throughout areas of this group where cover is present. Food is provided by native and cultivated vegetation, and water is available from springs and streams. The areas making up this group consist of native grasslands that have a limited variety of shrubs and trees to provide feed for deer during periods when prolonged snow cover occurs.

Upland game birds are mourning dove, California quail, and Hungarian and chukar partridge. Natural or artificial drainageways that have perennial water or springs are key areas for upland game birds. California quail require cover, provided by shrubs and trees, for roosting and for escaping enemies.

A few waterfowl are found along the larger perennial streams during fall and winter. They occasionally feed in upland wheat fields.

Such furbearers as mink, muskrat, beaver, and otter are in places along the larger perennial streams.

Other animals found on the soils of this group are coyotes, bobcats, badgers, skunks, porcupines, rabbits, ground squirrels, and mice.

Nongame birds are hawks, owls, eagles, ravens, magpies, and several kinds of songbird.

Perennial streams produce some rainbow trout and steelhead. Shallow, stony soils and underlying fractured basalt bedrock limit fish-pond construction on soils in this group.

WILDLIFE GROUP 2

This group consists of well-drained to somewhat excessively drained loams, sandy loams, and cobbly loams that formed in mixed eolian and sedimentary material. These soils are in broad, undulating areas on uplands dissected by narrow drainageways that have moderately steep and steep sides. The vegetation is grasses, forbs, shrubs, and juniper. Elevation ranges from 2,000 to 3,400 feet. Average annual precipitation ranges from 9 to 12 inches, average annual air temperature ranges from 46° to 50° F., and the frost-free period is 50 to 80 days at 32° and 100 to 130 days at 28°.

The mule deer population is low in areas of this group. The soils in this group have a low water-supplying capacity, which limits production of food plants. Distribution of deer is dependent upon water sources.

Upland game birds are mourning doves, Hungarian and chukar partridge, and California quail. All upland bird populations are small, with the possible exception of migrating doves that feed in dryland wheatfields early in fall.

Limited numbers of coyotes, bobcats, badgers, skunks, rabbits, ground squirrels, and mice use these areas.

Nongame birds are hawks, owls, eagles, ravens, magpies, and several kinds of songbirds.

Shallowness and stoniness limit fish-pond construction on soils in this group.

WILDLIFE GROUP 3

This group consists of well-drained to somewhat poorly drained loams, sandy loams, and clays that formed in mixed alluvium. These soils are nearly level and are on narrow terraces adjacent to drainageways. The native vegetation is grasses, forbs, and shrubs. Elevation ranges from 1,400 to 3,000 feet. Average annual precipitation ranges from 9 to 14 inches, average annual air temperature ranges from 46° to 51° F., and the frost-free period is 50 to 120 days at 32° and 90 to 150 days at 28°. Areas that have an elevation of less than 2,000 feet have a frost-free period of 130 days or more at a temperature of 32°.

Mule deer use these areas of this soil extensively as a source of food and water. The soils of this group are used for irrigated alfalfa crops, which provide a choice green food supply for mule deer during the dry period in summer.

Upland game birds are ring-necked pheasant, California quail, Hungarian and chukar partridge, mountain quail, and mourning doves. These soils produce many kinds of native and cultivated grasses, forbs, shrubs, and trees. Upland game birds can be attracted by providing and protecting choice food and cover plants. Seasonal flooding is sometimes a concern.

Waterfowl use the areas of this group in fair numbers. They can be attracted by providing and protecting choice food plants. In many places, however, developing ponded water for waterfowl is difficult.

Mink, muskrat, beaver (fig. 13), and otter are along the larger streams in fair numbers.

Coyotes, bobcats, badgers, skunks, raccoons, porcupines, rabbits, ground squirrels, and mice are common on the soils of this group and adjacent groups.

Nongame birds are hawks, owls, eagles, ravens, magpies, and songbirds. These are numerous throughout this and adjacent groups.

Rainbow trout and steelhead are common in the larger streams. Seasonal flooding and the hazard of channel erosion generally limit fish-pond development on soils in this group.

WILDLIFE GROUP 4

This group consists of well-drained loams to clays, mostly gravelly, cobbly, stony, or shaly, that formed dominantly in tuff and loess. These soils are on narrow ridgetops, steep to very steep sides of canyons, and moderately steep, rolling uplands. The native vegetation is

Figure 13.—**Beaver dam on Hay Creek. Mixed alluvial land is nearby.**

grasses, forbs, shrubs, and juniper. Elevation ranges from 1,300 to 4,500 feet. Average annual precipitation ranges from 9 to 16 inches, average annual air temperature ranges from 42 to 50° F., and the frost-free period is 30 to 120 days at 32° and 90 to 150 days at 28°.

Mule deer use the areas of this group extensively where there is an abundance of native grasses, forbs, and shrubs along with cultivated areas that can produce choice food, such as wheat and dryland alfalfa. Some of the higher elevations receive heavy snow cover that forces deer to migrate to lower elevations during winter.

Upland game birds are California quail, doves, Hungarian and chukar partridge, and mountain quail. Choice food crops, such as wheat, are grown in some areas of these soils. Where water is scarce, so are game birds.

Coyotes, bobcats, badgers, and skunks are common on the soils of this group. There are a few porcupines and raccoons. Rabbits, ground squirrels, and mice are abundant in places.

Hawks, owls, eagles, ravens, magpies, and several kinds of songbird are common on the soils of this group.

The soils in this group have few limitations for fishpond construction.

WILDLIFE GROUP 5

This group consists of well-drained gravelly and cobbly loams that formed in volcanic ash, clay, and basalt colluvium. These soils are smooth and rolling on ridgetops and steep to very steep on the sides of canyons. The native vegetation is Douglas-fir and ponderosa pine and an understory of shrubs, sedges, and grasses. Elevation ranges from 3,500 to 5,000 feet. Average annual precipitation ranges from 16 to 25 inches, average annual air temperature ranges from 40° to 45° F., and the frost-free period is 10 to 60 days at 32° and 80 to 110 days at 28°.

Mule deer use the areas of this group in fair numbers during spring, summer, and fall. Snow cover forces deer to migrate to lower elevations during winter. There are many kinds of grasses, forbs, shrubs, and trees.

Upland game birds are a few blue and ruffed grouse and mountain quail.

Coyotes, bobcats, badgers, skunks, and raccoons are seasonally abundant on the soils of this group. Rabbits, ground squirrels, tree squirrels, and mice are common.

Nongame birds are hawks, owls, eagles, ravens, magpies, and several kinds of songbird. They are seasonally abundant.

The soils in this group have slight limitations for fish-pond construction.

WILDLIFE GROUP 6

This group consists of well-drained stony, very stony, and shaly loams that formed in loess mixed with residuum weathered from shale, tuff, and sandstone. These soils are on narrow ridgetops and are moderately steep to steep on the sides of canyons. The native vegetation is grasses, forbs, shrubs, and juniper. Elevation ranges from 2,500 to 4,500 feet. Average annual precipitation ranges from 11 to 16 inches, average annual air temperature ranges from 42° to 49° F., and the frost-free period is 30 to 80 days at 32° and 90 to 130 days at 28°.

Mule deer use these soil areas extensively because of the abundance of many kinds of native grasses, forbs, and shrubs. Bitterbrush is particularly abundant and vigorous on these soils and is a very important winter food plant for deer.

Upland game birds are a few California quail, mountain quail, and chukar and Hungarian partridge.

Coyotes, bobcats, badgers, skunks, porcupine, rabbits, ground squirrels, and mice are common on the soils of this group.

Nongame birds are hawks, owls, eagles, ravens, and magpies and several kinds of songbirds.

Moderate permeability and shallow depth to fractured bedrock limit fish-pond development on soils in this group.

Engineering Uses of the Soils [6]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among the properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage, shrink-swell potential, grain-size distribution, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect the construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate the performance of structures already built with the properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 5 and 6, which show, respectively, several estimated soil properties significant in engineering and interpretations of engineering properties.

This information, along with the soil map and other parts of this survey, can be used to make interpretations in addition to those given in table 6, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or require excavations to depths greater than those shown in the tables, generally depths of more than about 5 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some terms used in soil science have special meaning that is not known to all engineers. The Glossary at the back of this survey defines many of these terms as they are commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system and the system adopted by the American Association of State Highway Officials (AASHO).

In the Unified system (*15*) soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are 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 having characteristics of two classes are designated by symbols for both classes; for example, CH or MH.

The AASHO system (*1*) is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups that range from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7. are clay soils that have low strength when wet and are the poorest soils for subgrade.

[6] ELWIN A ROSS, engineer, Soil Conservation Service, assisted in preparation of this section.

TABLE 5.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils for referring to other series that appear in the first column.

Soil series and map symbols	Hydrologic group	Depth to bedrock	Depth from surface of typical profile	Classification		
				Dominant USDA texture	Unified	AASHO
		In.	*In.*			
Agency: AgC	C	20–40	0–21	Loam	SM or ML	A–4
			21–32	Loam to clay loam	SC, ML, or CL	A–6
			32	Basalt bedrock.		
*Bakeoven: BaC, BcC For Condon part of BcC, refer to Condon series.	D	4–12	0–7	Very gravelly loam	GM or GC	A–2 or A–4
			7	Basalt bedrock.		
*Boardtree. ByF For Yawkey part, refer to Yawkey series.	C	40–60+	0–31	Gravelly loam and loam	SM or ML	A–4 or A–2
			31–44	Clay	CH	A–7
*Condon: CnC, CoC For Bakeoven part of CoC, refer to Bakeoven series.	C	20–40	0–29	Silt loam	ML	A–4
			29	Basalt bedrock.		
Court: CrB	B	60+	0–29	Sandy loam	SM	A–2 or A–4
			29–38	Very gravelly loamy sand	GP	A–1
*Curant. CtE, CtF For Tub part, refer to Tub series.	B	60+	0–33	Silt loam	ML	A–4
			33–60	Silt loam	ML or SM	A–4
Day: DaE	D	60+	0–40	Clay	CH	A–7
Degner: DeE, DgC	C	40–60	0–13	Gravelly loam	SM or ML	A–4
			13–27	Very gravelly clay	GC or CH	A–7 or A–2
			27–40	Very gravelly loam	GM	A–2 or A–4
			40	Bedrock.		
Donnybrook: DoE	D	12–20	0–18	Gravelly loam and gravelly sandy clay loam	SM or GM	A–2 or A–4
			18–22	Tuff.		
Era: ErB, ErE	B	[6] 40–60+	0–48	Loam	ML	A–4
*Ginser: GgE, GnF, GpF For Prag part of GpF, refer to Prag series.	C	60+	0–25	Gravelly silt loam	GM or ML	A–4
			25–33	Very gravelly silty clay loam	GM or ML	A–2 or A–4
			33–60	Weathered tuff	GM or ML	A–2 or A–4
Gribble: GrD	D	[6] 20–40	0–10	Cobbly loam	GM or ML	A–4
			10–30	Cobbly clay	GC or CH	A–7
			30–37	Very cobbly clay loam	GC	A–6 or A–2
			37–43	Silica-cemented very gravelly and very cobbly hardpan.	----------	----------
Hankins: HaE	C	[6] 40–60	0–13	Cobbly loam	ML	A–4
			13–45	Cobbly clay	CH	A–7
			45	Weathered tuff.		
Lamonta: LaC	D	[6] 20–30	0–16	Cobbly loam	ML	A–4
			16–22	Cobbly clay	CH or MH	A–7
			22	Indurated silica-cemented hardpan.	----------	----------
Lickskillet: LcE, LeF	D	12–20	0–7	Very stony loam	GM or ML	A–4 or A–2
			7–13	Very stony clay loam	GM or ML	A–2, A–4, or A–6
			13	Basalt bedrock.		
*Lithgow: LgE For Sorf part, refer to Sorf series.	C	[6] 20–40	0–22	Gravelly loam and gravelly clay loam.	GM or SM	A–2 or A–4
			22	Tuff.		
Lithgow, deep variant: LhF	B	40–60+	0–60	Very shaly loam	GM	A–2 or A–4

significant in engineering

in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions
The sign > means more than; the sign < means less than]

Coarse fragments more than 3 inches [1]	Percentage passing sieve—[2]				Liquid limit [3]	Plasticity index [3]	Permeability	Available water holding capacity	Reaction	Shrink-swell potential	Corrosivity of uncoated steel
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)							
							In. per hr.	*In. per in. of soil*	*pH value*		
5–10	85–100	75–100	65–95	45–75	30–35	5–10	0. 6–2. 0	0. 13–0. 18	6. 6–7. 3	Moderate	Moderate.
5–10	70–90	55–90	45–90	35–70	30–40	11–15	0. 2–0. 6	0. 12–0. 19	6. 6–7. 3	Moderate	Moderate.
15–45	30–75	20–70	15–65	10–50	25–35	5–10	0. 2–0. 6	0. 06–0. 14	6. 1–7. 3	Low	Moderate.
	60–95	45–85	40–80	25–65	[4] NP	[4] NP	2. 0–6. 0	0. 23–0. 25	6. 1–6. 5	Very low	Moderate.
	80–95	70–90	60–90	50–85	50–65	30–40	<0. 06	0. 12–0. 16	6. 6–7. 3	High	High.
	100	100	90–100	80–90	25–35	5–10	0. 6–2. 0	0. 20–0. 25	6. 1–7. 3	Moderate	Moderate.
	80–100	65–100	40–70	20–40	NP	NP	2. 0–6. 0	0. 09–0. 13	6. 6–7. 3	Very low	Moderate.
20–25	30–45	15–25	10–20	2–10	NP	NP	>20	0. 03–0. 05	[5] 7. 9–8. 4	Very low	Low.
	80–100	75–100	70–100	50–90	25–40	5–10	0. 6–2. 0	0. 17–0. 21	6. 6–7. 3	Moderate	Low.
	70–90	50–85	45–85	35–75	25–40	5–10	0. 6–2. 0	0. 14–0. 19	[5] 7. 4–8. 4	Low	Low
	90–100	90–100	80–100	70–95	60–70	30–45	<0. 06	0. 14–0. 16	[5] 6. 6–9. 0	Very high	High.
	75–100	60–100	50–95	35–75	25–35	5–10	0. 6–2. 0	0. 12–0. 18	6. 6–7. 3	Moderate	Moderate.
10–15	50–60	25–60	20–60	20–55	50–65	25–35	0. 2–0. 6	0. 06–0. 14	6. 6–7. 3	High	Moderate.
10–15	50–60	25–60	20–55	15–45	25–35	5–10	0. 6–2. 0	0. 08–0. 14	[5] 7. 9–8 4	Low	Moderate.
0–10	65–80	55–70	45–65	20–50	25–35	1–5	0. 2–0. 6	0. 12–0. 15	[5] 6. 6–8. 4	Moderate	Moderate.
	95–100	90–100	75–95	55–75	NP	NP	2. 0–6. 0	0. 13–0. 18	6. 6–9. 2	Very low	Low.
0–15	60–80	50–70	45–70	35–65	25–30	5–10	0. 6–2. 0	0. 13–0. 18	5. 6–6. 5	Low	Low.
15–30	45–80	35–70	35–70	30–65	30–40	5–10	0. 2–0. 6	0. 07–0. 10	6. 1–6. 5	Low	Moderate.
0–10	65–80	55–70	50–70	40–65	30–40	5–10	0. 06–0. 2	0 05–0. 10	6. 1–6. 5	Low	Moderate.
15–40	65–90	60–85	50–80	35–65	25–35	5–10	0. 2–0. 6	0. 11–0. 15	6. 1–6. 5	Moderate	Low.
30–50	60–90	55–70	50–70	40–65	45–55	20–30	<0. 06	0. 08–0. 11	6. 6–7 8	High	High.
45–55	50–75	45–70	40–70	30–50	30–40	10–15	0. 2–0. 6	0. 10–0. 14	[5] 7. 9–8. 4	Moderate	Moderate.
							<0. 06				
25–50	95–100	90–100	75–95	55–75	25–35	0–8	0. 6–2. 0	0. 10–0. 16	6. 6–7. 3	Low	Low.
25–50	95–100	90–100	80–100	70–95	50–65	25–35	0. 06–0. 2	0. 09–0. 15	6. 6–7. 3	High	High.
30–45	90–100	90–100	75–95	55–75	25–35	5–10	0. 6–2. 0	0. 11–0. 15	6. 6–7. 3	Low	Low.
30–45	90–100	90–100	80–100	70–95	50–80	25–45	<0. 06	0. 10–0. 14	6. 6–7. 3	High	High.
							<0. 06				
30–55	60–80	50–75	40–70	30–55	25–30	2–8	0. 6–2. 0	0. 08–0. 14	6. 6–7. 3	Low	Low.
55–75	35–80	30–75	25–75	20–60	25–40	5–15	0. 6–2. 0	0. 06–0. 13	6. 6–7. 3	Low	Moderate
	35–80	25–70	20–70	20–50	35–40	5–10	0. 2–0. 6	0. 10–0. 18	6. 6–7. 3	Low	Moderate.
	30–70	20–60	20–60	10–45	20–25	0–5	2. 0–6. 0	0. 08–0. 11	6. 6–8 4	Low	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Hydrologic group	Depth to bedrock	Depth from surface of typical profile	Classification		
				Dominant USDA texture	Unified	AASHO
		In.	*In.*			
Madras: MaC, MbE	C	[6] 20–30	0–13	Loam	SM or ML	A–4
			13–23	Clay loam and gravelly clay loam.	SC or CL	A–6
			23–29	Calcareous fractured pan.		
			29	Strongly cemented hardpan.		
McCoin: McD	D	10–20	0–9	Loam	ML	A–4
			9–16	Loam and clay loam	ML or CL	A–4
			16	Sandstone.		
McMeen: MmC	C	[6] 20–40	0–8	Silt loam	ML	A–4
			8–27	Silty clay loam	CL	A–6
			27–39	Strongly calcareous cemented hardpan.		
Metolius: MtB	B	40–60+	0–49	Sandy loam and loam	SM or ML	A–2 or A–4
			49–60	Gravelly loam	ML or SM	A–4
Mixed alluvial land: Mx. Too variable to rate.						
Playas: Pa. Too variable to rate.						
Prag: PrE, PvE	C	[6] 20–40	0–9	Cobbly loam	ML	A–4
			9–40	Cobbly clay	CH	A–7
			40	Rhyolytic tuff.		
Rail: Ra	D	60+	0–60	Clay	CH	A–7
Riverwash: Rh Too variable to rate.						
Rock outcrop-Rubble land complex: Rr. Too variable to rate.						
Rough broken and stony land: Ru Too variable to rate.						
Searles: SeF	C	20–40	0–13	Very stony loam	GM or ML	A–2 or A–4
			13–31	Very gravelly clay loam	GM or GC	A–2
			31	Rhyolite.		
Simas: SlE, SmF, SnE	C	60+	0–23	Cobbly silty clay or silty clay.	CH	A–7
			23–45	Calcareous tuff	ML	A–4
Sorf: SoE	C	60+	0–5	Very stony loam	ML	A–4
			5–12	Clay	CH	A–7
			12–30	Clay loam	CL	A–7
			30	Tuff.		
Tub: TgC, ThE, TuF, TvD	C	60+	0–12	Gravelly clay loam	CL	A–7
			12–29	Gravelly clay	CH	A–7
			29–40	Gravelly clay loam	CH	A–7
Utley: UtE	B	40–60	0–53	Shaly loam	SM or ML	A–4
			53	Shale bedrock.		
Venator: VeE	D	12–20	0–8	Shaly loam	GM or SM	A–2 or A–4
			8–16	Very shaly clay loam	GC or SP	A–2
			16	Shale.		
Willowdale: Wd	B	60+	0–48	Loam	ML	A–4

significant in engineering—Continued

Coarse fragments more than 3 inches [1]	Percentage passing sieve—[2]				Liquid limit [3]	Plasticity index [3]	Permeability	Available water holding capacity	Reaction	Shrink-swell potential	Corrosivity of uncoated steel
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0 074 mm.)							
							In. per hr.	*In. per in of soil*	*pH value*		
----------	80–100	65–100	55–95	40–75	25–30	0–5	0. 6–2. 0	0. 13–0. 18	6. 6–7. 3	Low----------	Low.
0–15	65–100	55–100	50–100	40–80	25–40	11–15	0. 6–2. 0	0. 14–0. 19	[5] 6. 6–7. 8	Moderate-----	Moderate.
10–15	90–95	85–90	70–85	50–70	20–30	0–5	0. 6–2. 0	0. 14–0. 16	6. 6–7. 3	Low----------	Low.
10–15	90–95	85–90	75–90	60–75	30–40	5–10	0. 6–2. 0	0. 16–0. 19	6. 6–7. 3	Low----------	Moderate.
0–10	90–95	85–90	75–90	60–80	30–35	0–5	0. 6–2. 0	0. 17–0. 21	6. 6–7. 3	Low----------	Low.
0–10	90–95	85–90	80–90	70–85	35–40	11–20	0. 2–0. 6	0. 17–0. 21	6. 6–7. 8	Moderate-----	High.
----------	95–100	95–100	55–95	30–75	NP	NP	2. 0–6. 0	0. 18–0. 22	6. 6–7. 3	Low----------	Low.
----------	75–95	65–90	55–85	40–70	NP	NP	2. 0–6. 0	0. 15–0. 18	[5] 7. 9–8. 4	Low----------	Very low.
15–25	85–95	80–90	70–85	50–70	25–30	0–5	0. 6–2. 0	0. 13–0. 16	6. 6–7. 3	Low----------	Low.
25–40	85–95	75–85	70–80	55–80	50–65	30–40	0. 06–0. 2	0. 10–0. 14	6. 6–8. 4	High----------	High.
----------	100	100	90–100	75–95	60–75	30–45	<0. 06	0. 14–0. 16	6. 6–8. 4	High----------	High.
15–30	60–90	45–80	40–75	25–60	25–35	0–5	0. 6–2. 0	0. 10–0. 15	6. 6–7. 3	Low----------	Low.
10–15	30–50	20–40	20–40	15–30	30–40	11–15	0. 6–2. 0	0. 07–0. 13	6. 6–7. 3	Moderate-----	Moderate.
15–45	80–90	75–90	70–90	70–85	50–70	25–40	0. 06–0. 2	0. 12–0. 14	[5] 6. 6–9. 0	High----------	High.
15–30	80–90	75–90	65–80	50–80	30–35	5–10	0. 06–0. 2	0. 04–0. 08	[5] 7. 9–9. 0	Low----------	Moderate.
30–50	90–95	90–95	75–90	55–70	30–35	5–10	0. 6–2. 0	0. 10–0. 14	6. 6–7. 3	Low----------	Moderate.
10–50	90–95	90–95	80–95	70–85	50–70	25–40	0. 06–0. 2	0. 15–0. 23	6. 6–7. 3	High----------	High.
10–50	90–95	90–95	80–95	65–75	41–45	15–25	0. 2–0. 6	0. 11–0. 16	[5] 7. 9–9. 0	Moderate-----	High.
0–25	80–95	70–85	65–85	50–70	41–50	15–25	0. 2–0. 6	0. 17–0. 19	6. 6–7. 3	High----------	High.
0–25	80–95	70–85	65–85	50–80	50–70	25–40	0. 6–0. 2	0. 12–0. 14	6. 6–7. 8	High----------	High.
0–25	80–95	70–85	65–85	50–70	50–60	25–35	0. 2–0. 6	0. 17–0. 19	[5] 7. 9–8. 4	High----------	High.
----------	65–95	50–90	40–85	35–70	25–35	5–10	0. 6–2. 0	0. 11–0. 17	6. 6–7. 3	Low----------	Low.
----------	50–80	35–70	30–65	20–50	NP	NP	0. 6–2. 0	0. 09–0. 14	6. 1–6. 5	Low----------	Low.
----------	20–50	10–45	10–45	5–35	30–40	10–15	0. 2–0. 6	0. 06–0. 15	6. 6–7. 3	Low----------	Moderate.
----------	95–100	95–100	80–95	55–75	25–35	5–10	0. 6–0. 2	0. 17–0. 20	[5] 7. 9–8. 4	Low----------	Moderate.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Hydrologic group	Depth to bedrock	Depth from surface of typical profile	Classification		
				Dominant USDA texture	Unified	AASHO
		In	*In.*			
*Wrentham: WrF—Rock outcrop part too variable to rate.	C	20–40	0–9	Silt loam and gravelly silt loam.	ML or SM	A–4
			9–28	Very cobbly clay loam	GC, SM, or ML	A–2 or A–6
			28	Basalt bedrock.		
Yawkey—Mapped only with Boardtree soils.	C	40–60+	0–6	Gravelly loam	SM or ML	A–4
			6–48	Gravelly clay loam and very gravelly clay.	GC or GP	A–7 or A–2

[1] Estimates are for percentage by weight.
[2] Estimates are based on material less than 3 inches in diameter. Refer to soil descriptions for estimates of material larger than 3 inches in diameter.
[3] Estimates are based on material that passes the No. 40 sieve.

TABLE 6.—*Interpretation of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils for referring to other series that

Soil series and map symbols	Suitability as source of—		Degree and kind of limitation for—			
	Topsoil	Road fill	Local roads and streets	Dwellings without basements	Septic tank absorption fields	Sewage lagoons
Agency: AgC	Fair to poor: 3 to 20 percent coarse fragments.	Poor: moderate shrink-swell potential, bedrock at depth of 20 to 40 inches.	Moderate: bedrock at depth of 20 to 40 inches, moderate shrink-swell potential.	Moderate: bedrock at depth of 20 to 40 inches; moderate shrink-swell potential.	Severe: bedrock at depth of 20 to 40 inches; moderately slow permeability.	Severe: bedrock at depth of 20 to 40 inches; slopes of 1 to 12 percent.
*Bakeoven: BaC, BcC. For Condon part of BcC, refer to Condon series.	Poor: excessive coarse fragments.	Poor: bedrock at depth of 4 to 12 inches.	Severe: bedrock at depth of 4 to 12 inches.	Severe: bedrock at depth of 4 to 12 inches.	Severe: bedrock at depth of 4 to 12 inches.	Severe: bedrock at depth of 4 to 12 inches.
*Boardtree: ByF. For Yawkey part, refer to Yawkey series.	Poor: excessive coarse fragments; slopes of 20 to 70 percent.	Poor: high shrink-swell potential, slopes of 20 to 70 percent.	Severe: high shrink-swell potential, slopes of 20 to 70 percent; high frost hazard.	Severe: high shrink-swell swell potential, high frost hazard.	Severe: clay at depth of 20 to 40 inches; very slow permeability below depth of 20 to 40 inches.	Severe: slopes of 20 to 70 percent.
*Condon: CnC, CoC. For Bakeoven part of CoC, refer to Bakeoven series.	Good to fair slopes of 2 to 12 percent.	Poor: bedrock at depth of 20 to 40 inches.	Moderate: bedrock at depth of 20 to 40 inches.	Moderate: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches, slopes of 2 to 12 percent.

significant in engineering—Continued

Coarse fragments more than 3 inches [1]	Percentage passing sieve—[2]				Liquid limit [3]	Plasticity index [3]	Permeability	Available water holding capacity	Reaction	Shrink-swell potential	Corrosivity of uncoated steel
	No 4 (4.7 mm.)	No. 10 (2 0 mm)	No. 40 (0 42 mm.)	No 200 (0.074 mm.)							
							In. per hr.	*In. per in. of soil*	*pH value*		
10–30	65–95	60–90	55–90	40–80	25–35	5–10	0. 6–2. 0	0. 14–0. 19	6. 1–7. 3	Low	Moderate.
50–75	45–90	35–85	30–85	25–70	30–40	11–15	0. 2–0. 6	0. 06–0. 15	6. 6–7. 3	Moderate	Moderate.
10–30	80–90	75–90	65–85	45–70	25–35	5–10	0. 6–2. 0	0. 09–0. 15	6. 1–6. 5	Low	Low.
10–30	15–60	10–50	10–50	10–50	40–50	15–25	0. 2–0. 6	0. 05–0. 12	6. 6–7. 3	Moderate	High.

[4] NP = Nonplastic.
[5] Free lime occurs in this layer.
[6] Hardpan or tuff.

engineering properties

in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions appear in the first column of this table]

Soil features affecting—					
Pond reservoir areas	Embankments, dikes, and levees	Irrigation	Terraces and diversions	Grassed waterways	Winter grading
Bedrock at depth of 20 to 40 inches.	Poor resistance to piping; medium permeability when compacted; poor compaction characteristics.	Bedrock at depth of 20 to 40 inches, available water holding capacity is 2 to 7 inches.	Bedrock at depth of 20 to 40 inches; short, irregular slopes.	Available water holding capacity is 2 to 7 inches.	Bedrock at depth of 20 to 40 inches; slopes of 1 to 12 percent.
Bedrock at depth of 4 to 12 inches, subject to seepage.	Bedrock at depth of 4 to 12 inches; excessive coarse fragments larger than 3 inches.	Not needed	Not needed	Not needed	Bedrock at depth of 4 to 12 inches; excessive coarse fragments.
Low permeability when compacted; slopes of 20 to 70 percent.	Good resistance to piping; low permeability when compacted; fair to poor compaction characteristics; subject to cracking.	Not needed	Not needed	Not needed	Low stability on freezing and thawing; highly plastic material below depth of 20 to 40 inches; slopes of 20 to 70 percent.
Bedrock at depth of 20 to 40 inches; subject to seepage.	Poor resistance to piping; medium permeability when compacted, poor compaction characteristics.	Bedrock at depth of 20 to 40 inches, slopes of 2 to 12 percent.	Bedrock at depth of 20 to 40 inches.	Available water holding capacity is 4 to 9 inches.	Bedrock at depth of 20 to 40 inches, silt loam texture.

TABLE 6.—*Interpretation of*

Soil series and map symbols	Suitability as source of—		Degree and kind of limitation for—			
	Topsoil	Road fill	Local roads and streets	Dwellings without basements	Septic tank absorption fields	Sewage lagoons
Court: CrB	Good	Good	Slight	Slight	Slight	Severe: very rapid permeability in substratum.
*Curant: CtE, CtF. For Tub part, refer to Tub series.	Fair to poor: slopes of 8 to 70 percent.	Fair to poor: moderate shrink-swell potential; slopes of 8 to 70 percent.	Moderate to severe: slopes of 8 to 70 percent; moderate shrink-swell potential.	Moderate to severe: slopes of 8 to 70 percent; moderate shrink-swell potential.	Severe: slopes of 8 to 70 percent; moderate permeability.	Severe: slopes of 8 to 70 percent.
Day: DaE	Poor: clay texture.	Poor: very high shrink-swell potential.	Severe: very high shrink-swell potential.	Severe: very high shrink-swell potential.	Severe: very slow permeability.	Severe: slopes of 8 to 40 percent.
Degner: DeE, DgC	Poor: slopes of 2 to 40 percent, 0 to 25 percent coarse fragments.	Fair to poor: moderate to high shrink-swell potential; bedrock at depth of 40 to 60 inches.	Severe: slopes of 2 to 40 percent; moderate to high shrink-swell potential.	Severe: slopes of 2 to 40 percent; moderate to high shrink-swell potential.	Severe: slopes of 2 to 40 percent; moderately slow permeability; bedrock at depth of 40 to 60 inches.	Severe: slopes of 2 to 40 percent.
Donnybrook: DoE	Poor. 20 to 30 percent coarse fragments; slopes of 10 to 40 percent.	Fair to poor: slopes of 10 to 40 percent; moderate shrink-swell potential; tuff at depth of 12 to 20 inches.	Severe: slopes of 10 to 40 percent; tuff at depth of 12 to 20 inches.	Moderate to severe: slopes of 10 to 40 percent; moderate shrink-swell potential.	Severe: tuff at depth of 12 to 20 inches; slopes of 10 to 40 percent.	Severe: tuff at depth of 12 to 20 inches, slopes of 10 to 40 percent.
Era: ErB, ErE	Good to poor: slopes of 1 to 40 percent.	Good to poor: slopes of 1 to 40 percent.	Slight to severe: slopes of 1 to 40 percent.	Slight to severe: slopes of 1 to 40 percent.	Moderate to severe: slopes of 1 to 40 percent; bedrock at depth of 40 to 60 inches.	Severe: moderately rapid permeability; slopes of 1 to 40 percent.
*Ginser: GgE, GnF, GpF. For Prag part of GpF, refer to Prag series.	Poor: slopes of 12 to 70 percent; 20 to 40 percent coarse fragments.	Fair to poor: slopes of 12 to 70 percent.	Severe: slopes of 12 to 70 percent.	Moderate to severe: slopes of 12 to 70 percent.	Severe: slopes of 12 to 70 percent; moderately slow permeability.	Severe: slopes of 12 to 70 percent.
Gribble: GrD	Poor: 20 to 45 percent coarse fragments.	Poor: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: very slow permeability; hardpan at depth of 20 to 40 inches.	Severe: hardpan at depth of 20 to 40 inches; slopes of 5 to 20 percent.

engineering properties—Continued

Soil features affecting—					
Pond reservoir areas	Embankments, dikes, and levees	Irrigation	Terraces and diversions	Grassed waterways	Winter grading
Gravel at depth of 20 to 40 inches; very rapid permeability in substratum.	Fair resistance to piping, medium to high permeability when compacted; fair to good compaction characteristics.	Gravel at depth of 20 to 40 inches, available water holding capacity is 3 to 6 inches.	Susceptible to siltation.	Available water holding capacity is 3 to 6 inches, susceptible to channel siltation.	All features favorable.
Slopes of 8 to 70 percent.	Poor resistance to piping; medium permeability when compacted; poor compaction characteristics.	Not needed	Not needed	Not needed	Slopes of 8 to 70 percent.
Slopes of 8 to 40 percent; other features favorable.	Good resistance to piping; low permeability when compacted; fair to poor compaction characteristics.	Slow intake rate; slopes of 8 to 40 percent.	Not needed	Not needed	Highly plastic clay throughout
Slopes of 2 to 40 percent.	Poor resistance to piping; medium permeability when compacted; poor compaction characteristics; bedrock at depth of 40 to 60 inches.	Not needed	Not needed	Not needed	Slopes of 2 to 40 percent.
Tuff at depth of 12 to 20 inches, slopes of 10 to 40 percent.	Fair to poor resistance to piping, medium permeability when compacted; fair to good compaction characteristics.	Not needed	Not needed	Not needed	Tuff at depth of 12 to 20 inches; 20 to 30 percent coarse fragments; slopes of 10 to 40 percent.
Moderately rapid permeability, slopes of 1 to 40 percent.	Poor resistance to piping; medium permeability when compacted; fair to good compaction characteristics.	Available water holding capacity is 5 to 11 inches; slopes of 1 to 40 percent.	Slopes of 1 to 40 percent; short, irregular slopes.	Available water holding capacity is 5 to 11 inches; highly erodible; susceptible to channel siltation.	All features favorable.
Slopes of 12 to 70 percent.	Fair to poor resistance to piping; medium permeability when compacted; fair to poor compaction characteristics.	Not needed	Not needed	Not needed	Slopes of 12 to 70 percent; 20 to 40 percent coarse fragments.
Hardpan at depth of 20 to 40 inches; very slow permeability.	Good resistance to piping, low permeability when compacted, good to poor compaction characteristics.	Slow intake rate; 20 to 45 percent coarse fragments; very slow permeability.	Hardpan at depth of 20 to 40 inches, 20 to 45 percent coarse fragments.	Cuts expose clayey materials, 20 to 45 percent coarse fragments, available water holding capacity is 2 to 5 inches.	Hardpan at depth of 20 to 40 inches, clay texture at depth of 10 to 30 inches; highly plastic material at depth of 10 to 30 inches.

TABLE 6.—*Interpretation of*

Soil series and map symbols	Suitability as source of—		Degree and kind of limitation for—			
	Topsoil	Road fill	Local roads and streets	Dwellings without basements	Septic tank absorption fields	Sewage lagoons
Hankins: HaE	Poor: 15 to 35 percent coarse fragments; slopes of 15 to 50 percent.	Poor: high shrink-swell potential.	Severe: high shrink-swell potential; slopes of 15 to 50 percent.	Severe: high shrink-swell potential; slopes of 15 to 50 percent.	Severe: slopes of 15 to 50 percent; slow permeability.	Severe: slopes of 15 to 50 percent.
Lamonta: LaC	Poor: 20 to 35 percent coarse fragments.	Poor: high shrink-swell potential.	Severe: high shrink-swell potential; hardpan at depth of 20 to 30 inches.	Severe: high shrink-swell potential.	Severe: hardpan at depth of 20 to 30 inches; very slow permeability.	Severe: hardpan at depth of 20 to 30 inches.
Lickskillet: LcE, LeF	Poor: 30 to 60 percent coarse fragments.	Poor: slopes of 15 to 70 percent; very stony.	Severe: slopes of 15 to 70 percent; bedrock at depth of 12 to 20 inches.	Severe: bedrock at depth of 12 to 20 inches.	Severe: bedrock at depth of 12 to 20 inches; slopes of 15 to 70 percent.	Severe: slopes of 15 to 70 percent; bedrock at depth of 12 to 20 inches.
*Lithgow: LgE For Sorf part, refer to Sorf series.	Poor: slopes of 20 to 50 percent; 20 to 30 percent coarse fragments.	Fair to poor: slopes of 20 to 50 percent; tuff at depth of 20 to 40 inches.	Severe: slopes of 20 to 50 percent.	Severe: slopes of 20 to 50 percent.	Severe: tuff at depth of 20 to 40 inches, slopes of 20 to 50 percent.	Severe: slopes of 20 to 50 percent; tuff at depth of 20 to 40 inches.
Lithgow, deep variant: LhF	Poor: slopes of 50 to 70 percent; 25 to 70 percent coarse fragments.	Poor: slopes of 50 to 70 percent.	Severe: slopes of 50 to 70 percent.	Severe: slopes of 50 to 70 percent.	Severe: slopes of 50 to 70 percent.	Severe: slopes of 50 to 70 percent.
Madras: MaC, MbE	Fair to poor. slopes of 1 to 40 percent.	Poor: slopes of 1 to 40 percent; hardpan at depth of 20 to 30 inches.	Moderate to severe: moderate shrink-swell potential, slopes of 1 to 40 percent.	Moderate to severe: slopes of 1 to 40 percent; moderate shrink-swell potential.	Severe: hardpan at depth of 20 to 30 inches, slopes of 1 to 40 percent.	Severe: hardpan at depth of 20 to 30 inches; slopes of 1 to 40 percent.
McCoin: McD	Poor: soft sandstone at depth of 10 to 20 inches; 10 to 20 percent coarse fragments.	Poor: soft sandstone at depth of 10 to 20 inches; slopes of 5 to 20 percent.	Moderate to severe: soft sandstone at depth of 10 to 20 inches; slopes of 5 to 20 percent.	Moderate to severe: soft sandstone at depth of 10 to 20 inches; slopes 5 to 20 percent.	Severe: soft sandstone at depth of 10 to 20 inches.	Severe: soft sandstone at depth of 10 to 20 inches.
McMeen: MmC	Fair: 5 to 15 percent coarse fragments.	Fair to poor: plasticity index of 10 to 20; moderate shrink-swell potential.	Moderate to severe: plasticity index of 10 to 20; moderate shrink-swell potential.	Moderate: moderate shrink-swell potential.	Severe: hardpan at depth of 20 to 40 inches; moderately slow permeability.	Severe: hardpan at depth of 20 to 40 inches.
Metolius: MtB	Good	Good to fair: excess fines.	Moderate: excess fines.	Severe: subject to occasional flooding.	Moderate: subject to occasional flooding.	Severe: moderately rapid permeability.

engineering properties—Continued

Soil features affecting—					
Pond reservoir areas	Embankments, dikes, and levees	Irrigation	Terraces and diversions	Grassed waterways	Winter grading
Slopes of 15 to 50 percent; slow permeability.	Good resistance to piping; low permeability when compacted; fair compaction characteristics.	Not needed	Not needed	Not needed	Highly plastic material; 15 to 35 percent coarse fragments; slopes of 15 to 50 percent.
Hardpan at depth of 20 to 30 inches; very slow permeability.	Fair to poor resistance to piping; low permeability when compacted; fair to poor compaction characteristics.	Hardpan at depth of 20 to 30 inches; available water holding capacity is 2 to 4 inches; 20 to 35 percent coarse fragments.	Hardpan at depth of 20 to 30 inches; 20 to 35 percent coarse fragments.	Cuts expose clayey material; 20 to 35 percent coarse fragments.	Hardpan at depth of 20 to 30 inches.
Bedrock at depth of 12 to 20 inches; subject to seepage.	Bedrock at depth of 12 to 20 inches; coarse fragments larger than 3 inches in diameter.	Not needed	Not needed	Not needed	Bedrock at depth of 12 to 20 inches; slopes of 15 to 70 percent; coarse fragments.
Slopes of 20 to 50 percent, tuff at depth of 20 to 40 inches; moderately slow permeability.	Fair resistance to piping; medium permeability when compacted; fair to good compaction characteristics.	Not needed	Not needed	Not needed	Tuff at depth of 20 to 40 inches; slopes of 20 to 50 percent; 20 to 30 percent coarse fragments.
Not needed	Fair resistance to piping; medium permeability when compacted; fair to good compaction characteristics.	Not needed	Not needed	Not needed	Slopes of 50 to 70 percent.
Hardpan at depth of 20 to 30 inches; medium permeability; slopes of 1 to 40 percent.	Poor to fair resistance to piping; low to medium permeability when compacted; fair to good compaction characteristics.	Hardpan at depth of 20 to 30 inches, available water holding capacity is 3 to 6 inches.	Hardpan at depth of 20 to 30 inches.	Available water-holding capacity is 3 to 6 inches; hardpan at depth of 20 to 30 inches.	Hardpan at depth of 20 to 30 inches.
Soft sandstone at depth of 10 to 20 inches; moderate permeability.	Good resistance to piping; medium permeability when compacted; poor compaction characteristics.	Soft sandstone at depth of 10 to 20 inches, available water holding capacity is 1.5 to 3.5 inches.	Soft sandstone at depth of 10 to 20 inches.	Available water holding capacity is 1.5 to 3.5 inches, sandstone at depth of 10 to 20 inches.	Soft sandstone at depth of 10 to 20 inches.
Hardpan at depth of 20 to 40 inches, moderately slow permeability.	Good resistance to piping; low permeability when compacted; fair to good compaction characteristics	Hardpan at depth of 20 to 40 inches, available water holding capacity is 4 to 9 inches.	Hardpan at depth of 20 to 40 inches.	Available water holding capacity is 4 to 9 inches.	Hardpan at depth of 20 to 40 inches; silty clay loam subsoil.
Moderately rapid permeability.	Poor resistance to piping; medium permeability when compacted; poor to fair compaction characteristics.	Available water holding capacity is 7 to 13 inches.	All features favorable.	Available water holding capacity is 7 to 13 inches; subject to siltation.	All features favorable.

TABLE 6.—*Interpretation of*

Soil series and map symbols	Suitability as source of—		Degree and kind of limitation for—			
	Topsoil	Road fill	Local roads and streets	Dwellings without basements	Septic tank absorption fields	Sewage lagoons
Mixed alluvial land: Mx. Too variable to rate.						
Playas: Pa. Too variable to rate.						
Prag: PrE, PvE	Poor: 15 to 25 percent coarse fragments.	Poor: high shrink-swell potential.	Severe: slopes of 5 to 50 percent; high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: tuff at depth of 20 to 40 inches; slow permeability.	Severe: tuff at depth of 20 to 40 inches; slopes of 5 to 50 percent.
Rail: Ra	Poor: clay-texture.	Poor: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: somewhat poorly drained, very slow permeability.	Slight
Riverwash: Rh. Too variable to rate.						
Rock outcrop-Rubble land complex: Rr. Too variable to rate.						
Rough broken and stony land. Ru. Too variable to rate.						
Searles: SeF	Poor 20 to 50 percent coarse fragments.	Poor: moderate shrink-swell potential; slopes of 35 to 65 percent.	Severe: slopes of 35 to 65 percent; bedrock at depth 20 to 40 inches.	Severe: slopes of 35 to 65 percent.	Severe: slopes of 35 to 65 percent, bedrock at depth of 20 to 40 inches.	Severe: slopes of 35 to 65 percent; bedrock at depth of 20 to 40 inches.
Simas: SlE, SmF, SnE.	Poor· 15 to 40 percent coarse fragments.	Poor: high shrink-swell potential.	Severe: slopes of 8 to 70 percent; high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: slow permeability; slopes of 8 to 70 percent.	Severe: slopes of 8 to 70 percent.
Sorf: SoE	Poor: 20 to 35 percent coarse fragments.	Poor: high shrink-swell potential.	Severe slopes of 5 to 40 percent; high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: slow permeability; slopes of 5 to 40 percent.	Severe: slopes of 5 to 40 percent.
Tub: TgC, ThE, TuF, TvD.	Poor· 10 to 35 percent coarse fragments.	Poor· high shrink-swell potential; slopes of 1 to 70 percent.	Severe: slopes of 1 to 70 percent; high shrink-swell potential.	Severe: high shrink-swell potential.	Severe: slow permeability.	Severe: slopes of 1 to 70 percent.

engineering properties—Continued

Soil features affecting—					
Pond reservoir areas	Embankments, dikes, and levees	Irrigation	Terraces and diversions	Grassed waterways	Winter grading
Slopes of 5 to 50 percent; tuff at depth of 20 to 40 inches.	Good resistance to piping; low permeability when compacted; fair to poor compaction characteristics.	Not needed	Not needed	Not needed	Tuff at depth of 20 to 40 inches; slopes of 5 to 50 percent; 15 to 25 percent coarse fragments.
Very slow permeability.	Good resistance to piping; low permeability when compacted; fair to poor compaction characteristics.	Slow intake rate; very slow permeability; somewhat poorly drained.	Not needed	Subject to siltation; clay texture throughout.	Clay texture throughout; somewhat poorly drained.
Severe: slopes of 35 to 65 percent, bedrock at depth of 20 to 40 inches.	Fair to good resistance to piping, low to medium permeability when compacted.	Not needed	Not needed	Not needed	Slopes of 35 to 65 percent; bedrock at depth 20 to 40 inches.
Slopes of 8 to 70 percent; slow permeability.	Good resistance to piping, low permeability when compacted; fair to poor compaction characteristics.	Not needed	Not needed	Not needed	15 to 40 percent coarse fragments.
Slopes of 5 to 40 percent	Good resistance to piping; low permeability when compacted; fair to poor compaction characteristics.	Not needed	Not needed	Not needed	20 to 35 percent coarse fragments.
Slopes 1 to 70 percent	Good resistance to piping; low permeability when compacted; fair to poor compaction characteristics.	Not needed	Not needed	Not needed	10 to 35 percent coarse fragments.

TABLE 6.—*Interpretation of*

Soil series and map symbols	Suitability as source of—		Degree and kind of limitation for—			
	Topsoil	Road fill	Local roads and streets	Dwellings without basements	Septic tank absorption fields	Sewage lagoons
Utley: UtE	Fair to poor: 5 to 25 percent coarse fragments, slopes of 10 to 50 percent.	Fair to poor: slopes of 10 to 50 percent; excess fines.	Moderate to severe: slopes of 10 to 50 percent.	Moderate to severe: slopes of 10 to 50 percent.	Moderate to severe: slopes of 10 to 50 percent.	Severe: slopes, of 10 to 50 percent.
Venator: VeE	Poor: 20 to 50 percent coarse fragments.	Fair to poor: slopes of 10 to 40 percent.	Moderate to severe: shale at depth of 12 to 20 inches; slopes of 10 to 40 percent.	Severe: shale at depth of 12 to 20 inches; slopes of 10 to 40 percent.	Severe: shale at depth of 12 to 20 inches; slopes of 10 to 40 percent; moderately slow permeability.	Severe. shale at depth of 12 to 20 inches, slopes of 10 to 40 percent.
Willowdale: Wd	Good	Fair: excess fines.	Moderate: subject to occasional flooding.	Severe: subject to occasional flooding.	Severe: subject to occasional flooding.	Severe: medium permeability; subject to occasional flooding.
*Wrentham: WrF For Rock outcrop part, refer to Rock outcrop-Rubble land complex.	Poor: 10 to 40 percent coarse fragments.	Poor: slopes of 35 to 70 percent.	Severe: slopes of 35 to 70 percent; basalt at depth of 20 to 40 inches.	Severe: slopes of 35 to 70 percent.	Severe. basalt at depth of 20 to 40 inches; slopes of 35 to 70 percent.	Severe: basalt at depth of 20 to 40 inches, slopes of 35 to 70 percent.
Yawkey Mapped only with Boardtree soils.	Poor: 25 to 50 percent coarse fragments.	Poor: slopes of 30 to 70 percent.	Severe: slopes of 30 to 70 percent; susceptible to frost heaving.	Severe: slopes of 30 to 70 percent.	Severe: slopes of 30 to 70 percent.	Severe: slopes of 30 to 70 percent.

Tests performed by the Bureau of Public Roads in accordance with standard procedures of the AASHO system frequently differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material, or that passing the No. 200 sieve, is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of material up to 3 inches. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. A comparison of these and other systems of size limits for soil separates can be found in the PCA Soil Primer (*6*). Table 5 shows both the AASHO and the Unified classification for all soils mapped in the survey area.

Soil properties significant in engineering

Several estimated soil properties significant in engineering are shown in table 5. These estimates are made for representative soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 5.

Engineers and soil scientists have classified the soil series in the survey area into four hydrologic groups. The grouping is based on estimates of the intake of water during the latter part of a storm of long duration, after the soil profile is wet and has had an opportunity to swell, and without the protective effect of any vegetation. Hydrologic groups are useful in watershed planning. The four groups are:

Group A.—Soils that have a high infiltration rate when thoroughly wetted. These soils have a high rate of water transmission and low runoff potential. They are deep, are well drained or excessively drained, and consist chiefly of sand, gravel, or both.

engineering properties—Continued

Soil features affecting—					
Pond reservoir areas	Embankments, dikes, and levees	Irrigation	Terraces and diversions	Grassed waterways	Winter grading
Slopes of 10 to 50 percent; medium permeability.	Poor resistance to piping; medium permeability when compacted; poor compaction characteristics.	Not needed	Not needed	Available water holding capacity is 5 to 10 inches; slopes of 10 to 50 percent.	Slopes of 10 to 50 percent.
Shale at depth of 12 to 20 inches; slopes of 10 to 40 percent.	Good resistance to piping; low to high permeability when compacted; good compaction characteristics.	Not needed	Not needed	Not needed	Shale at depth of 12 to 20 inches; slopes of 10 to 40 percent.
Medium permeability.	Poor resistance to piping; medium permeability when compacted; poor compaction characteristics.	All features favorable.	Not needed	Susceptible to siltation.	All features favorable.
Slopes of 35 to 70 percent.	Poor resistance to piping; medium permeability when compacted; poor to fair compaction characteristics.	Not needed	Not needed	Not needed	Basalt at depth of 20 to 40 inches; slopes of 35 to 70 percent; 10 to 40 percent coarse fragments.
Slopes of 30 to 70 percent.	Good resistance to piping; low to high permeability when compacted; good compaction characteristics.	Not needed	Not needed	Not needed	Slopes of 30 to 70 percent; 25 to 50 percent coarse fragments.

Group B.—Soils that have a moderate infiltration rate when thoroughly wetted. These soils have a moderate rate of water transmission and moderate runoff potential. They are moderately deep or deep, are moderately well drained or well drained, and are medium textured to moderately coarse textured.

Group C.—Soils that have a slow infiltration rate when thoroughly wetted. These soils have a slow rate of water transmission and high runoff potential. They have a layer that impedes downward movement of water, or they are moderately fine textured or fine textured and have a slow infiltration rate.

Group D.—Soils that have a slow infiltration rate when thoroughly wetted. The rate of water transmission is very slow, and runoff potential is very high. In this group are (1) clay soils that have high shrink-swell potential; (2) soils that have a permanent high water table; (3) soils that have a claypan or clay layer at or near the surface; and (4) soils that are shallow over nearly impervious material.

Depth to bedrock is distance from the surface of the soil to the upper surface of the rock layer.

The soils in the survey area are deep enough over the water table that the water table does not affect their use.

Soil texture is described in table 5 in the standard terms used by the Department of Agriculture. These terms take into account relative 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 the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, gravelly loamy sand. Sand, silt, clay, and some of the other terms used in USDA textural classification are defined in the Glossary at the back of this survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the

material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 5.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly porosity, structure, and texture. The estimates in table 5 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water holding capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material that has this rating.

Corrosivity, as used in table 5, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel. Rate of corrosion of uncoated steel is related to such soil properties as drainage, texture, total acidity, and electrical conductivity of the soil material. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel should be used to avoid or minimize damage. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Corrosivity of concrete is low in this area because all soils have a pH of more than 6.1.

Engineering interpretations of the soils

The interpretations in table 6 are based on the estimated engineering properties of soils shown in table 5, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of the Trout Creek-Shaniko Area. In table 6, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for irrigation, ponds and reservoirs, embankments, terraces and diversions, grassed waterways, and winter grading. For these particular uses, table 6 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties are generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Moderate* means some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance.

Soil suitability is rated by the terms good, fair, and poor, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 6.

Suitability of sand and gravel is not given in table 6 because most of the soils are not suitable as a source of sand and gravel. The Court and Gribble soils are rated fair as a source of gravel.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants grown on it to fertilizer; and absence of substances toxic to plants. Texture of the soil material and content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that results at the area from which topsoil is taken.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Local roads and streets, as rated in table 6, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base that consists of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are (1) load supporting capacity and stability of the subgrade and (2) workability and quantity of cut and fill material available. The AASHO and Unified classifications of the soil material and the shrink-swell potential indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Dwellings, as rated in table 6, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness,

susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to about 5 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or bedrock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and has sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic-matter content, and slope; if the floor needs to be leveled, depth to bedrock is important. Soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification and the amount of stones, if any, which influences the ease of excavation and compaction of the embankment material.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among the factors that are unfavorable.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of the soil below the surface layer and in a fragipan or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or depth to the water table or bedrock.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope, depth to bedrock or other unfavorable material, presence of stones, permeability, and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Grassed waterways are natural or constructed waterways, typically broad and shallow, that are covered by grass for protection against erosion. They are used to conduct surface water away from cropland. Features that affect suitability of a soil for establishing and maintaining vegetation in a waterway are hazard of erosion, reaction, and natural fertility. For soils that are level or nearly level and for soils that do not require waterways, "Not needed" is shown in the column showing features that affect suitability for grassed waterways.

Winter grading involves moving, mixing, and compacting soil during cold weather. It is affected by such soil features as texture, slope, kind and amount of clay, amount and size of coarse fragments, and amount of soil moisture.

Formation, Morphology, and Classification of the Soils

This section has three main parts. The first explains the five factors of soil formation, the second discusses the morphology of the soils, and the third classifies the soils of the survey area.

Factors of Soil Formation

Soil is the product of the action of climate and living organisms upon the parent material, as conditioned by the local relief and time.

Except for time, these are complexes of many individual factors. The influence of climate on soils depends not only on temperature, rainfall, and humidity, but also on the relief and the physical characteristics of the soil or soil material. Also, one group of factors influences another. Vegetation is largely controlled by climate.

Climate

The climate of the Trout Creek-Shaniko Area is semiarid, and most of the annual precipitation falls in winter.

The effects of climate are expressed directly in soil formation and indirectly through the control of the kinds and amount of native vegetation. In this survey area temperature in winter is so low that the soils are frozen for long periods. During these periods many processes of soil formation are completely stopped. Average annual air temperature is normally 45° to 52° F. at low elevations and decreases to less than 40° at elevations of more than 4,000 feet. Frost is likely to occur every month of the year in areas of poor air drainage. 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, resulting in low evaporation losses of about 23.5 inches at Madras (evaporation pan). Soil temperatures differentiate Tub soils from Prag soils and Wrentham soils from Ginser soils.

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. Average annual precipitation is normally 9 to 12 inches in the vicinity of Willowdale and ranges to about 16 to 25 inches in the conifer forests, where there is an increase in elevation. It is concentrated mainly in the period of October to June. Summer precipitation is spotty and scant, and it is often lost to evaporation. Rainfall is insufficient to

leach the soils strongly, but the upper few inches of many virgin soils is neutral to slightly acid. The soil is generally leached to a greater depth than those soils that formed in regions where more of the rainfall occurs in summer.

Organisms

In well-drained areas throughout the 9- to 11-inch precipitation zone, the natural vegetation is mostly bluebunch wheatgrass and Sandberg bluegrass. Here the soils have an A horizon that is about 6 to 10 inches thick and mostly has less than 1 percent organic matter. Big sagebrush is present, but there is no Idaho fescue or bitterbrush. In the zone of about 11 to 16 inches of precipitation, the natural vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, Idaho fescue, big sagebrush, and bitterbrush. These soils have an A horizon that is about 12 to 20 inches thick, and they have more than 1 percent organic matter. As precipitation increases to more than 16 inches and elevation increases to more than 3,800 feet, conifer forests replace the grass and shrub vegetation. The depth and amount of leaching increase as the bunchgrasses give way to trees.

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 abuandance of organic matter, and soils in these areas commonly have a thick, dark-colored A horizon.

Animals and insects that burrow in the soil also influence the kinds of soil that form, but they probably have less influence than plants on the soils of this survey area.

Red carpenter ants are active in most of these soils but concentrate their activity in areas of low rainfall and warmer temperature and on soils that have weak to moderate structure and medium to moderately coarse texture.

Badger activity is common on sandy or loamy soils that are relatively free of stones.

Parent material

The soils of the Trout Creek-Shaniko Area formed in five main kinds of parent material: (1) material resulting from the weathering of bedrock and local movement on sloping uplands and plateaus, (2) alluvium deposited in alluvial fans and terraces, (3) pumice from geologically recent volcanic explosions, (4) stream alluvium on flood plains and low benches, and (5) eolian deposits of loess on uplands.

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 material on uplands has produced soils that are generally shallow over bedrock and are stony, except for those that overlie soft, clayey rocks. 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.

Some of the oldest exposed geologic formations in the survey area are those of the Triassic, Jurassic, or Cretaceous Periods. They are only minor in extent, and most of them have been covered up by succeeding formations. They mainly consist of shale and sandstone. The material fractures readily upon initial weathering by mechanical means, but the smaller fragments resist further chemical and mechanical disintegration. Utley and Venator soils formed in residuum weathered from this shale and sandstone.

The Clarno Formation underlies the soil mantle over much of the survey area (*2*). It consists of both tuff and lava of Eocene age. Degner, Donnybrook, Hankins, Lithgow, McMeen, Prag, Rail, Simas, Sorf, Tub, and Yawkey soils formed from these materials. Shallow skeletal soils, Rough broken and stony land, and Rock outcrop-Rubble land complex formed in the lavas. In places, faulting and folding have resulted in metamorphism.

The John Day Formation was deposited over most of the Clarno Formation and consisted mostly of tuff and ash. However, except where protected, this formation has been lost through natural geologic erosion. The formation weathers into material high in content of clay, and such soils as the Day soils form in it.

The Columbia River Basalt flow has preserved the major ridges adjacent to Trout Creek. Shaniko ridge in the northern part of the survey area is representative of the Columbia River Basalt. Such soils as Bakeoven and Lickskillet soils formed in residuum weathered from these lavas and are very shallow and very stony. Most of the lava in this survey area south of Shaniko ridge is thin and fragmented.

The Dalles Formation has been deposited over older formations, but only in the extreme western part of the survey area (*4*). It was built up slowly, as is evidenced by the many layers of buried soils in the regolith and the intervening thin lava flows. Most of the material is loamy and resists weathering. Loamy soils, such as Madras, McCoin, Agency, Era, Metolius, and Willowdale soils, formed in this material.

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. The thickness ranges from 2 inches to 4 feet and generally diminishes from north to south in the survey area. Ginser, Condon, McMeen, and Wrentham soils have loess throughout the A and B horizons.

During Recent geologic times, volcanic ash and pumice have been deposited over the survey area. This material is mostly from Newberry Crater and Mount Mazama (*16*). It was deposited over the entire area, but preferential erosion has concentrated it in alluvium and on north and northeast exposures. Some soils have inherited their light weight directly from pumice. Court, Era, Metolius, and Boardtree soils formed at least partly from volcanic ash and pumice.

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 dryer 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.

Another important feature is slope gradient. Steep soils commonly have thinner and less distinct soil horizons

than gently sloping soils, are subject to more erosion, and retain less water.

Most soils in the Trout Creek-Shaniko Area are well drained, and the wetter soils occur only on flood plains and in depressions on the upland plateau.

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. Other things being equal, younger soils have less horizon differentiation than older soils. For example, Rail and Willowdale soils formed in recent alluvium, and although leaching has been strong enough to concentrate carbonates below a depth of about 18 inches, no B horizon has formed. Lithgow and Sorf soils formed under less precipitation but over a longer period of time, and they have a distinct B horizon.

Morphology of the Soils

In the Trout Creek-Shaniko Area, the most important soil features that result from genetic processes are (1) an A horizon that has an accumulation of organic matter, (2) a B horizon that has an accumulation of silicate clays, (3) a hardpan in well-drained soils, presumably cemented by alkali-soluble material, (4) silica movement in ashy soils, (5) the soil, platy condition of the A horizon in places, (6) the vesicular surface layer of some soils, and (7) the presence of calcium carbonate in the lower horizons of some soils.

Organic matter has accumulated in the uppermost layers of all of the soils to form an A horizon. The content of organic matter is higher in Mollisols than it is in Aridisols. The soils under conifer forest derive much of their organic matter from deep-rooted woody plants. These soils commonly have less organic matter in the A horizon than soils under grass, but they commonly have a higher amount on a volume basis for the whole soil profile.

Formation and translocation of silicate clay minerals is one of the chief factors in the formation of soil horizons in many of the soils in this survey area. Most of the soils that formed on old landforms have distinct horizonation. Silicate clays accumulate to form a textural B horizon by (1) relative concentration of clay because of the removal of other constitutents from the horizons, (2) concentration in a subsurface horizon by leaching from above, and (3) formation in place by weathering. Soils on old landforms, including the Tub, Simas, Sorf, Degner, Hankins, Gribble, Lamonta, Searles, and Prag soils, have distinct horizonation. Some of their soil properties, however, probably originated in previous times when the climate was vastly different from what it is today. Soils that formed on young landforms or in unweatherable parent material have little or no horizonation.

The mineralogy of most soils in the survey area is mixed, but the Day, Degner, Gribble, Hankins, Lamonta, Rail, Simas, Prag, Sorf, Tub, Yawkey, and other soils have 2:1 expanding lattice clay minerals. The effect of the expanding type of clay minerals is shown in Day soils, which have high cation exchange capacity, no textural B horizon, high shrink-swell capacity on wetting and drying, and prominent cracks on drying.

A silica-cemented hardpan, or duripan, has formed in Gribble, Lamonta, Madras, and McMeen soils. These soils are nearly level to rolling on upland plains and have a loamy texture that is commonly gravelly or cobbly. A hardpan has not been observed where the soil contains sandy material. The undersides of cobblestones in the lower part of the B horizon, and small stalactites on the underside of lamellae in the hardpan, have some accumulation of silica as well as some lime.

The A horizon in well-drained soils of the survey area commonly has thin platy structure.

The absence of calcium carbonate and less than complete base saturation in the upper horizons indicate that the leaching process has been active. Some soils, such as the Ginser and Prag soils, have been leached of most of their free carbonates. The presence of lime in lower horizons and relatively high base saturation in most soils, however, show that the leaching process is far from complete.

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 understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

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 woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification 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 (*8*, *12*).

The 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 of things that affect soil genesis. In table 7 the soil series of the Trout Creek-Shaniko Area are placed in categories of the current system. Classes of the current system are briefly defined 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 sets of soil-forming processes that have gone on. Each order is named with a word of three of four syllables ending in *sol*. An example is Mollisol.

SUBORDER.—Each order is divided into suborders that are based primarily on properties that influence soil genesis and that are important to plant growth, or were selected to reflect what seemed to be the most important variables within the orders. The names of suborders have exactly two syllables. The last syllable indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

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, in soil moisture and temperature regimes, and in base status. The names of great groups have three or four syllables and end with the name of a suborder. A prefix added to the name suggests something about the properties of the soil. An example is Haplaquoll (*Hapl*, meaning minimum degree of expression of pedogenic horizons, plus *aquoll*, the suborder of Mollisols that have an aquic moisture regime).

SUBGROUP.—Great groups are divided 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 representative of the great groups but do not indicate transitions to any other known kind of soil. The names of subgroups are derived by placing one or more adjectives before the name of the great group. The adjective Vertic is used for the subgroup that is transitional to Vertisols, a kind of clayey soil that cracks when dry. An example is Vertic Haplaquoll.

FAMILY.—The soil family groups soils within a subgroup that have physical and chemical properties that are similar enough to make responses to management and manipulation for use nearly the same for comparable phases. Among the properties considered, in horizons of major biological activity below plow depth, are particle-size distribution, mineralogy, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for particle size, mineralogy, temperature regime, and so on, that are used as family differentiae (see table 7). An example is Vertic Haplaquolls, fine, montmorillonitic, mesic.

Laboratory Data

Physical and chemical characteristics of some representative soils in the Trout Creek-Shaniko Area are given in table 8. The procedures used in making the analyses are described in Soil Survey Investigations Report No. 1 (*14*).

In preparation for laboratory analysis, soil samples were collected from pits. After air-drying, the samples were crushed and passed through a 2-millimeter, round-hole screen. The fraction greater than 2 millimeters in diameter is reported as a weighted percentage of the total sample. Analyses were made on soil material less than 2 millimeters in diameter. Results are reported on an oven-dry basis.

The particle-size distribution was determined by the pipette method. 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" (*11*). The calcium carbonate equivalent was measured from the amount of carbon dioxide evolved on acidification of the sample. Water held at 15 atmospheres tension was measured on disturbed samples in a pressure membrane apparatus. Cation-exchange capacity for Day and Era soils was by ammonium acetate extraction and for Condon and Tub soils, by sodium acetate. Extractable acidity was determined by the triethanolamine-barium chloride method. The percentage of base saturation is based on the sum of cations.

General Nature of the Area

This section provides general information about the relief and drainage, climate, history, transportation, water supply, and recreation of the Trout Creek-Shaniko Area. Census figures from the U.S. Census of Agriculture were not used, because the survey covers parts of three counties.

Relief and Drainage

The Trout Creek-Shaniko Area includes the parts of Wasco and Jefferson Counties that are east of the Deschutes River and a few square miles in the northwestern part of Crook County. The rolling plateau area is cut by numerous narrow valleys and rugged canyons, and here and there a lone butte rises several hundred feet above the surrounding terrain. Along the southern border of the survey area, the Ochoco Mountains slope upward to a crest of 1,500 to 2,000 feet above the general level of the plateau.

The survey area is characterized by extremely folded and faulted, complex mountains that have been eroded. The western edge of the survey area is the eastern extreme of a plain or plateau region composed mainly of sedimentary rock that shows little erosion.

The buttes across the southern part of the survey area have an elevation of 4,000 to 5,000 feet at their highest points. They are covered with conifer forest. Three major ridges lie to the north of these forested buttes. These ridges are incised by deep canyons that have moderately steep to steep sides and many rock outcrops and slump areas. They gradually decrease in elevation to about 2,000 feet above the Deschutes and John Day Rivers.

Patterned ground, locally called biscuit scabland, makes up about 95,000 acres, or more than 10 percent, of the Trout Creek-Shaniko Area. Patterned ground is the general term applied to biscuits or mounds, stone nets, and stone stripes that form distinct patterns on the ground surface (*13*) (fig. 14). The patterned ground in the Trout Creek-Shaniko Area probably resulted from thawing of ice wedges followed by erosion during a former period of "frost climate" (*5*).

TABLE 7.—*Classification of soil series*

Series	Family	Subgroup	Order
Agency	Fine-loamy, mixed, mesic	Xerollic Camborthids	Aridisols.
Bakeoven	Loamy-skeletal, mixed, mesic	Lithic Haploxerolls	Mollisols.
Boardtree	Medial over clayey, mixed, frigid	Typic Vitrandepts	Inceptisols.
Condon	Fine-silty, mixed, mesic	Typic Haploxerolls	Mollisols.
Court	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic.	Calciorthidic Haploxerolls	Mollisols.
Curant	Fine-silty, mixed, mesic	Calcic Pachic Haploxerolls	Mollisols.
Day	Very fine, montmorillonitic, mesic	Typic Chromoxererts	Vertisols
Degner	Clayey-skeletal, montmorillonitic, mesic	Calcic Argixerolls	Mollisols
Donnybrook	Loamy, mixed, mesic, shallow	Calciorthidic Haploxerolls	Mollisols.
Era	Coarse-loamy, mixed, mesic	Calciorthidic Haploxerolls	Mollisols
Ginser	Loamy-skeletal, mixed, frigid	Pachic Haploxerolls	Mollisols.
Gribble	Clayey-skeletal, montmorillonitic, mesic	Argic Durixerolls	Mollisols.
Hankins	Fine, montmorillonitic, frigid	Pachic Ultic Argixerolls	Mollisols.
Lamonta	Fine, montmorillonitic, mesic	Abruptic Aridic Durixerolls	Mollisols.
Lickskillet	Loamy-skeletal, mixed, mesic	Lithic Haploxerolls	Mollisols.
Lithgow	Loamy-skeletal, mixed, mesic	Xerollic Haplargids	Aridisols.
Lithgow, deep variant.	Loamy-skeletal, mixed, mesic	Xerollic Camborthids	Aridisols.
Madras	Fine-loamy, mixed, mesic	Xerollic Durargids	Aridisols.
McCoin	Loamy, mixed, mesic, shallow	Aridic Haploxerolls	Mollisols.
McMeen	Fine-loamy, mixed, mesic	Entic Durixerolls	Mollisols.
Metolius	Coarse-loamy, mixed, mesic	Durixerollic Camborthids	Aridisols
Prag	Fine, montmorillonitic, frigid	Pachic Palexerolls	Mollisols.
Rail	Fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
Searles	Loamy-skeletal, mixed, mesic	Aridic Argixerolls	Mollisols.
Simas	Fine, montmorillonitic, mesic	Aridic Calcic Argixerolls	Mollisols.
Sorf	Fine, montmorillonitic, mesic	Xerollic Paleargids	Aridisols.
Tub	Fine, montmorillonitic, mesic	Calcic Pachic Argixerolls	Mollisols.
Utley	Fine-loamy, mixed, frigid	Pachic Haploxerolls	Mollisols
Venator	Loamy-skeletal, mixed, mesic	Lithic Haploxerolls	Mollisols.
Willowdale	Fine-loamy, mixed, mesic	Cumulic Haploxerolls	Mollisols.
Wrentham	Loamy-skeletal, mixed, mesic	Pachic Haploxerolls	Mollisols
Yawkey	Clayey-skeletal, montmorillonitic, frigid	Pachic Ultic Haploxerolls	Mollisols.

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 is classified as a Condon silt loam. Frost heaving and rodents are probably the cause of mixing of small amounts of basalt fragments larger than 2 millimeters in diameter throughout the soil. The soil in the mounds is somewhat more rapidly drained than the adjacent Bakeoven soils.

Associated features are the stone nets, which in places encircle the mounds, and the stone polygons on the Bakeoven soils that surround the mounds. 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 thawing of ice wedges (*7*).

Where slope is steep, the stone nets and polygons form sorted stripes, or rows, of rock that vary in length and width. The mounds commonly occupy the gentle upper slopes of 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.

The drainageways in the survey area are mostly parallel to the ridges in a dendritic pattern. Trout Creek, the largest drainageway, flows from south to north diagonally to the Jefferson County line. Then it flows west, through what appears to be a fault, into the Deschutes River. Willow Creek flows west from the area of Grizzly Butte through the plateau region and enters the Deschutes River near Madras.

The eastern third of the survey area is drained by Currant and Cherry Creeks, which flow into the John Day River. These streams are subject to periodic cloudbursts that have filled otherwise minor stream channels with cobblestones and gravel. Many tributaries to these streams are level enough across the channel to drive a motor vehicle.

The northern part of the survey area, or Shaniko Ridge area, is drained partly by Bakeoven Creek, which flows into the Deschutes River at Maupin. Numerous small drainageways dissect Shaniko Ridge and drain into the John Day River.

The major streams in the survey area are normally perennial, but late in summer the flow is insufficient to provide irrigation water. The stability of streambeds is generally low, and there is vertical and lateral cutting. Mass-wasting is taking place on nearly all watersheds. None of the stream systems has developed terraces. The stream channels have a large amount of debris, especially after high-intensity storms. Stream gradient is more than 1 percent, and turbidity occurs in all streams during periods of runoff.

TABLE 8.—*Physical and chemical*

[Analyses of Condon and Tub soils by Soil Survey Laboratory, Soil Conservation Service, Riverside, California.

Soil and horizon [1]	Depth	Particle-size distribution							Particles		
		Very coarse sand (2.0–1.0 mm.)	Coarse sand (1 0–0. 5 mm.)	Medium sand (0.5–0.25 mm.)	Fine sand (0 25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0. 5–0.002 mm.)	Clay (less than 0.002 mm.)	0.2–0.02 mm.	0.02–0.002 mm.	Larger than 2.0 mm.
	In	*Pct*	*Pct*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct*	*Pct.*	*Pct.*	*Pct.*
Condon silt loam:											
Ap	0–7	0. 9	2. 9	3. 2	11. 2	7. 3	58. 5	16. 0	42. 3	30. 1	1
B1	7–10	. 9	1. 7	2. 0	8. 5	6. 6	62. 9	17. 4	42. 3	32. 3	0
B21	10–18	1. 0	1. 3	1. 5	7. 2	6. 2	60. 8	22. 0	40. 0	30. 5	0
B22	18–29	1. 0	1. 3	1. 6	6. 6	6. 3	67. 0	16. 2	42. 6	34. 6	1
Day clay:											
A1	0–3	. 3	. 5	. 8	1. 6	4. 5	23. 0	69. 2	-------	19. 1	0
AC1	3–17	. 1	. 5	. 8	3. 4	3. 4	23. 1	68. 8	-------	19. 1	0
[2] AC2	17–25	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
C1ca	25–32	0	1. 2	1. 4	4. 9	4. 6	25. 5	62. 5	-------	20. 9	0
[2] C2ca	32–40	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Era loam:											
Ap	0–3	1. 7	2. 3	3. 1	10. 6	25. 2	40. 3	16. 7	-------	21. 3	8
A12	3–8	1. 1	2. 2	3. 1	15. 5	22. 1	39. 8	16. 3	-------	21. 4	7
[3] B2	8–16	2. 2	2. 3	3. 1	16. 0	22. 6	38. 9	14. 9	-------	21. 3	7
[3] B2	16–23	. 8	2. 6	3. 7	17. 3	22. 9	40. 3	12. 4	-------	21. 8	7
C1	23–37	. 6	2. 7	4. 0	18. 9	25. 4	40. 1	8. 2	-------	21. 2	5
C2ca	37–48	1. 0	2. 8	4. 4	22. 9	26. 9	36. 9	5. 1	-------	17. 9	5
Tub gravelly clay loam:											
Ap	0–6	2. 0	3. 1	2. 7	8. 0	5. 4	46. 5	31. 4	30. 7	27. 0	18
B1t	6–12	1. 5	2. 5	2. 2	7. 1	4. 0	35. 7	47. 0	24. 6	19. 6	17
B21t	12–20	2. 1	2. 6	2. 2	6. 9	3. 9	36. 1	46. 2	24. 4	20. 0	17
B22t	20–29	2. 0	2. 6	1. 7	4. 9	3. 5	41. 7	43. 6	25. 8	22. 2	13
B3ca	29–37	7. 4	10. 1	4. 9	7. 0	4. 6	27. 8	38. 2	20. 9	15. 4	44

[1] Location given under representative profile in the section "Descriptions of the Soils."
[2] Horizon not sampled.

History [7]

Embraced in the Trout Creek-Shaniko Area is a land in Oregon's high country that was well marked in pioneer days by trails of explorers, fur seekers, trail blazers, and gold hunters. None remained to develop the land or claim meadows along creek bottoms. Permanent settlers came later to found ranches that were expanded into some of the largest spreads in the Pacific Northwest (*3*).

The first white men to visit the interior of Oregon and leave records of their passage were members of the Peter Skene Ogden fur-hunting party of 1825–26. They were followed by Nathaniel Wyeth, also a fur hunter, in 1834. Then came Captain John C. Fremont, "The Pathfinder," in 1843.

Some of the Ogden party possibly hunted inland from the Deschutes River, lured by the fine flow of Trout Creek. Crooked River also provided a path for the Ogden fur hunters. They moved to the interior over the present Prineville site and headed for "Day's River" to the east and the big lakes of the Harney Valley.

Historians are certain that in the early 1860's, following the discovery of gold on the John Day at Canyon City, there was considerable foot, packstring, and stage traffic through the inland area. Trails and roads were cut deeply into the land along Muddy, Currant, and Cherry Creeks.

Near the present Jefferson County line was an important stopping point, Burnt Ranch. John N. Clark and his wife located there in 1865. In 1866 the ranch was raided by Indians and buildings were destroyed.

Need for a road across inland Oregon, to provide a shortcut to army posts and to Boise and Salt Lake City, was seen early. On May 19, 1860, Major Enoch Steen was sent to look over the inland country for a road site. He reported on his trip from Fort Dalles to the high, inland country:

". . . From the Columbia to Trout Creek, distance 79 miles, the country between the Deschutes and John Day Rivers is a high plateau, or tableland, with a general elevation of about 2,000 feet . . . The plateau is covered with a fine, luxuriant growth of bunchgrass (festuca) but is devoid of timber . . . This plateau would be well suited

[7] By PHIL F. BROGAN.

analyses of selected soils

Analyses of Day and Era soils by Oregon State University, Corvallis, Oregon. Dashes indicate analyses not made]

Reaction		Organic matter			Electrical conductivity	$CaCO_3$ equivalent	Moisture held at tension of 15 atmospheres	Cation-exchange capacity	Extractable acidity	Base saturation
Saturated paste	1:10 suspension	Organic carbon	Nitrogen	Carbon-nitrogen ratio						
pH	*pH*	*Pct.*	*Pct.*	*Pct.*	*Mmhos. per cm at 25° C*	*Pct*	*Pct.*	*Meq per 100 g.*	*Meq. per 100 g.*	*Pct.*
6. 5	6. 3	0. 80	0. 076	10. 5	0. 3	0	8. 5	22. 8	3. 8	81
6. 3	6. 1	. 69	. 073	9. 5	. 3	0	9. 0	23. 4	3. 7	81
6. 8	6. 5	. 56	. 066	8. 5	. 3	0	11. 1	28. 7	2. 9	88
7. 3	7. 4	. 48	. 065	7. 4	. 4	0	9. 3	28. 5	1. 6	93
7. 5	----------	. 58	. 040	14 5	----------	----------	28. 8	46. 9	5. 0	91
7. 0	----------	. 53	. 040	13. 3	----------	----------	29. 7	42. 9	2. 9	95
8. 2	----------	. 23	. 020	11. 5	----------	----------	26. 4	47. 6	3. 4	95
7. 4	----------	. 90	. 090	10. 0	----------	----------	9. 5	19. 7	3. 1	86
7. 6	----------	. 80	. 050	16. 0	----------	----------	10. 3	18. 8	2. 4	89
7. 7	----------	. 60	. 060	10. 0	----------	----------	9. 9	18. 7	3. 3	88
8. 0	----------	. 50	. 060	8. 3	----------	----------	9. 5	19. 5	1. 6	93
8. 5	----------	. 30	. 040	7. 5	----------	----------	8. 4	18. 2	. 5	98
9. 2	----------	. 20	. 030	6. 7	----------	----------	7. 9	15. 4	. 1	100
6. 5	6. 4	1. 63	. 121	13. 5	. 4	0	15. 8	32. 9	4. 6	86
6. 8	6. 7	1. 12	. 106	10. 6	. 4	0	23. 4	24. 4	3. 8	92
7. 0	6. 9	. 84	. 087	9. 7	. 4	0	23. 9	45. 3	2. 9	94
7. 4	7. 4	. 58	. 067	8. 7	. 5	0	22. 0	41. 6	1. 4	97
7. 6	8. 0	. 51	. 057	8. 9	. 5	5	26. 0	47. 9	----------	100

[3] Horizon split for sampling and analysis.

to a pastoral community if it were not for the great scarcity of timber."

Earlier, in 1859, Lt. J. C. Bonneycastle crossed the Deschutes River 55 miles south of Fort Dalles, on a 29-day trip to Salt Lake. On his return, he led a segment of his party over the Deschutes River near the mouth of the Warm Springs River. The trail he mapped approximated Highway 97 of the present.

Fertile lands and natural meadows in the area where Trout Creek merges with Antelope Creek and Hay Creek, north of present-day Madras, attracted early day stockmen. There, one of the largest cattle ranches of pioneer central Oregon, the Teal & Coleman spread, took shape in the 1870's.

The open-range country of eastern Jefferson County brought to the State one of its most colorful figures of early days, John G. Edwards, who was to develop the Hay Creek Ranch into a world-famous sheep operation. Actually, the spread, whose headquarters was in the rugged high country east of Madras, was established in 1873 by Dr. David Baldwin. The ranch has one of the most colorful histories in Oregon livestock operations.

Near Ashwood, on upper Trout Creek, Thomas H. Hamilton, a pioneer of 1874, founded one of the big stock ranches of the area. On Lower Trout Creek, there were other big ranches, one of them founded by Columbus Friend.

Eastern Jefferson County's only town of early days was the village of Ashwood. It dates its history to the 1870's, when the Whitfield T. Wood family settled on Trout Creek. The town got its name from nearby Ash Butte and the Wood family. Ashwood was a bustling town in early days, when the nearby Oregon King mine was in full operation.

In the eastern part of Jefferson County were a number of thriving communities at the turn of the century, when government land was plentiful and hills were grass covered. One of the communities was Axhandle, now known as Donnybrook.

As the inland region emerged from its pioneer stage, need for a railroad became evident. But it was not until 1894 that there was mention of plans for such a line. The first plan, considered in 1897, was a railroad from Biggs to Prineville. Engineers decided, however, that it would be impossible to get a train down into the low country from the high scarp that fringed the pioneer town of

Figure 14.—**Bakeoven-Condon complex, 2 to 20 percent slopes. A Condon soil is on the mounds, and surrounding the mounds is Bakeoven very cobbly loam, 2 to 20 percent slopes. Stone nets encircle the mounds.**

Antelope. Selected for the terminus was the locality to be known as Shaniko. It became one of the world's largest wool-shipping stations. The first trains reached Shaniko in 1900. When the Deschutes Gorge railroad lines were built in 1909–10, Shaniko gradually dwindled in importance.

However, from 1900 to 1911, Shaniko remained the principal shipping point for the big district now included in the Trout Creek-Shaniko Area.

Transportation

The nearest airport and the nearest railroad are at Madras. They provide only freight service or very limited passenger service.

Most roads in the Trout Creek-Shaniko Area are county roads or are privately built. U.S. Highways No. 97 and 197 pass through the Shaniko Ridge area in the northern part of the survey area. Oregon Highway No. 218 goes from Shaniko through Antelope and leaves the survey area at Clarno. The primary county roads lead from Madras and Willowdale to Ashwood, and then east to Cherry Creek Ranch near the John Day River or north from Ashwood to Antelope. There is one road that leads south from Willowdale through Grizzly and then to Prineville. Grizzly can be reached from Madras by U.S. Highway No. 26. The road base is adequate for year-round travel on the access roads leading to and from the operating ranches. Many private roads constructed in the conifer forest can support heavy equipment year round.

Climate [8]

Normal movement of air at the latitude of the survey area is from the Pacific Ocean, some 150 miles to the west. Airmasses cross first the Coast Range and then the Cascade Mountains. They give up much of their moisture, which falls as rain on the lower slopes and mostly as snow at higher levels. As a result, the air is very dry as it moves down the eastern slopes of the Cascades and out over the central Oregon plateau. In the course of about 35 airline miles, from the crest of the Cascades to the western border of the Trout Creek-Shaniko Area, the long-term average precipitation changes from nearly 65 inches to only 10 to 12 inches a year. The increase in elevation in the Ochoco Mountains causes a corresponding increase in precipitation.

There are two fairly distinct climatic regimes in the Trout Creek-Shaniko Area—the plateau and the middle and upper slopes of the Ochoco Mountains. Table 9 gives temperature and precipitation data for each of these areas. There is no reliable weather-observing station in the Trout Creek-Shaniko part of the mountains, but the data included for that area are based on records obtained at fairly comparable locations in adjacent areas.

Average annual precipitation ranges from about 10 inches a year along the western edge of the Trout Creek-Shaniko Area to approximately 25 inches in its southeastern corner (fig. 15). Approximately 33 percent of this

[8] By GILBERT L. STERNES, climatologist for Oregon, National Weather Service, U.S. Department of Commerce.

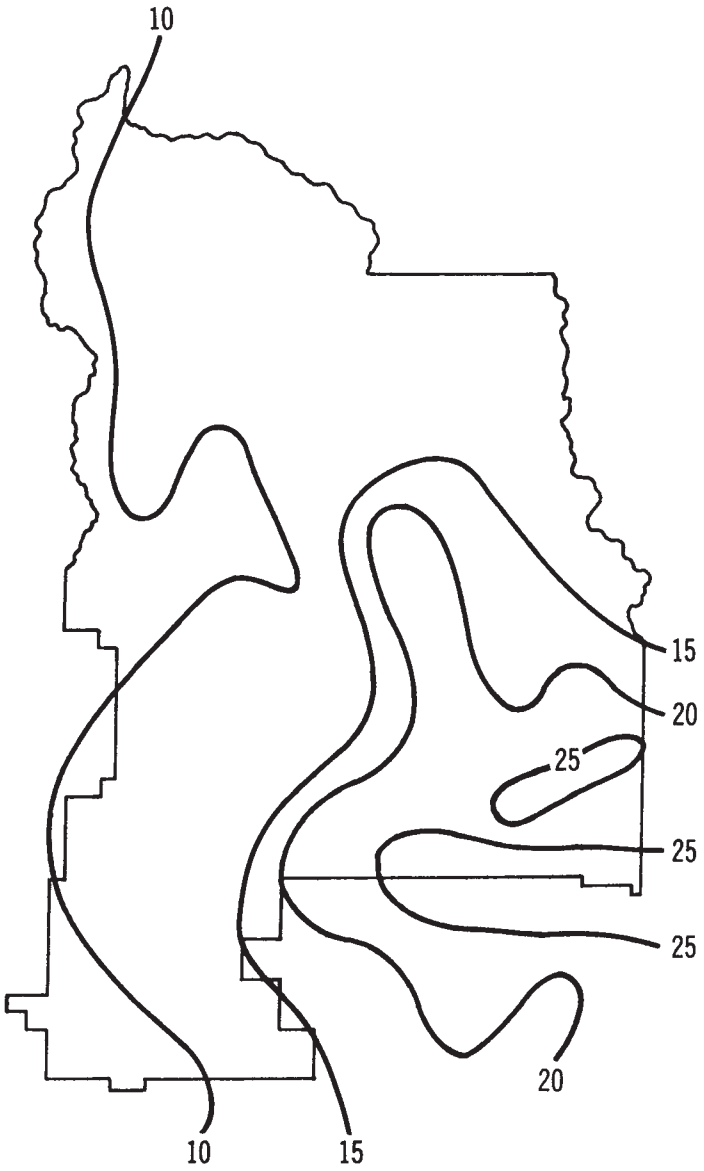

Figure 15.—**Average annual precipitation in the Trout Creek-Shaniko Area, shown in 5-inch intervals.**

annual total occurs during the period December through February; 26 percent in the period March through May; 15 percent in summer; and 26 percent in the period September through November. The driest period is July through September. During this 3-month period an average of only 10 percent of the year's total occurs. There are between 50 and 65 days a year in the plateau area when as much as 0.10 inch of precipitation occurs. This increases to 75 to 100 days on the higher slopes of the Ochoco Mountains.

At the lower elevations most of the precipitation falls as rain. There are only 6 to 8 days a year when an inch or more of snow falls. This snow typically melts in a matter of a few hours to a few days. In the mountains a much larger part of the precipitation is snow. Depth sometimes reaches 3 to 4 feet. A depth of 15 to 30 inches is common in most winters. During spring and summer an occasional very heavy rain of short duration accompanies a thunderstorm. These storms are confined to small areas, and the chance of any one place experiencing such a storm is only once in several years. When they do occur, runoff can be a very serious concern.

Officially recorded temperatures in the Trout Creek-Shaniko Area have ranged from −28° to 110° F. Temperatures as low as −45° have been recorded at Madras, only 2 or 3 miles west of the survey area, and some as high as 119° at Prineville, a few miles south of it. Minimums below freezing (32° or lower) can occur anywhere in the survey area any month in the year. Table 10 shows the probability of given temperatures after a specified date in spring and before a specified date in fall. Temperatures at least as low as 32° can be expected from 150 to 200 days a year, and those as low as 0° on 1 to 3 days annually. There is an average of 45 to 55 days each year when temperatures are 85° or more, 20 to 30 days of 90° or higher, and 1 to 3 days of 100° or higher. There is an average of 10 to 15 days annually when temperatures never get above freezing.

During the night hours, the air cools and its vapor content remains nearly constant, and relative humidity increases. It reaches its maximum about 4:00 A.M. At this time of day the monthly average ranges from 75 percent to 85 percent throughout the year. At 4:00 P.M., which is near the time of lowest relative humidity, the monthly average ranges from 65 to 70 percent in December to 20 to 25 percent in July. Under certain conditions, generally associated with a strong easterly or southeasterly wind, humidity drops to as low as 8 to 10 percent.

Evapotranspiration is a term used to identify the total moisture transferred from the soil to the atmosphere. It includes both the moisture lost by evaporation and that lost because of transpiration of plants. This is a figure that, when taken into account with the natural rainfall for the survey area, estimates the amount of supplemental moisture, through irrigation, that may be needed for crop development. Table 11 gives evapotranspiration data for the plateau area of the Trout Creek-Shaniko Area.

There is a close relationship between the rate at which many crops develop and the cumulative number of growing degree-days above selected bases. Growing degree-days are determined by adding the maximum and minimum temperatures for the day and dividing their sum by 2 to get the day's average temperature. The base (40°, 50°, or whatever is used) is subtracted from the average. The remainder is the number of growing degree-days. If the average is less than the base, the number is 0; there are no negative growing degree-days. Table 12 contains the monthly and annual average number of growing degree-days at Antelope.

During the 5-month period of November through March, 70 to 80 percent of the sky is covered with clouds on an average day. In July, however, there is only an average of 15 percent cloud cover.

Thunderstorms have occurred in the survey area every month in the year, but they are most likely late in spring and in summer. The long-term average ranges from 12 to 15 a year over the plateau area, gradually increasing to perhaps twice that number on the upper slopes of the

TABLE 9.—*Temperature and precipitation data* [1]

Month	Temperature				Precipitation								
	Average daily maximum	Average daily minimum	2 years in 10 will have at least 4 days with—		Average precipitation	1 year in 10 will have—		4 years in 10 will have—		Average snowfall	Maximum depth of snow on ground	Maximum number of days that have snow cover	Average depth of snow on days that have snow cover
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—	Less than—	More than—				
	°F	°F.	°F.	°F	In	In	In.	In	In.	In	In.		In
PLATEAU AREA													
January	40	21	54	−1	1.3	0.5	2.2	0.9	1.4	6	19	8	4
February	46	25	58	7	1.0	.4	2.0	.7	1.0	4	18	5	5
March	52	27	68	15	.9	.2	2.1	.6	.9	2	6	1	2
April	61	31	77	20	.7	.1	1.8	.5	.8	1	3	(2)	2
May	68	36	85	25	1.1	.2	2.8	.9	1.1	(3)	(3)	0	0
June	76	42	92	32	1.0	.2	2.3	.8	1.0	(3)	0	0	0
July	87	47	98	36	.2	.1	.8	.2	.3	0	0	0	0
August	85	45	97	35	.3	.1	1.2	.2	.3	0	0	0	0
September	77	40	92	29	.5	.2	1.4	.3	.5	0	0	0	0
October	65	33	81	21	1.0	.2	2.0	.6	.9	(3)	3	(2)	3
November	50	27	63	12	1.4	.3	2.9	1.3	1.6	1	7	1	2
December	43	25	57	9	1.4	.4	2.7	1.0	1.7	3	8	2	2
Annual	63	33	[4] 98	[5] −8	10.8	6.9	14.8	10.6	12.1	17	19	17	4
OCHOCO MOUNTAINS													
January	35	15	46	−6	2.2	.8	3.4	1.7	2.5	19	43	28	11
February	41	20	51	4	1.8	.5	3.1	1.3	1.8	12	36	26	14
March	47	22	62	11	1.6	.5	2.5	1.3	1.6	10	34	19	11
April	54	27	73	18	1.3	.2	2.1	1.1	1.3	3	15	1	4
May	64	32	80	23	1.7	.5	3.8	1.1	1.7	(3)	4	(2)	2
June	71	37	86	28	1.7	.2	3.6	1.3	1.7	(3)	2	(2)	1
July	82	41	93	32	.6	.1	1.4	.4	.5	0	0	0	0
August	81	39	92	31	.7	.1	2.1	.2	.7	0	0	0	0
September	75	35	89	26	.7	.1	1.5	.5	.8	(3)	0	0	0
October	61	30	77	22	1.7	.7	3.8	1.1	1.5	1	5	1	3
November	44	24	57	12	2.6	.9	4.6	2.3	2.7	7	14	7	4
December	37	20	47	5	2.8	1.0	5.4	1.9	2.3	12	26	19	7
Annual	58	29	[4] 96	[5] −11	19.4	12.6	25.3	17.3	19.8	64	43	101	10

[1] These are the best estimates if conditions are average. Because of differences in exposure and elevation, there are probably locations within divisions that differ from the value shown for particular months by as much as 5 to 10 percent.

[2] Less than one-half day.

[3] Less than one-half inch.

[4] Average annual maximum temperature.

[5] Average annual minimum temperature.

TABLE 10.—*Probability of given temperatures after a specified date in spring and before a specified date in fall*

PLATEAU

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	April 7	April 27	May 24	June 11	(1)
2 years in 10 later than	March 31	April 20	May 18	June 5	(1)
5 years in 10 later than	March 18	April 7	May 6	May 24	June 16
Fall:					
1 year in 10 earlier than	October 24	October 7	September 24	Setember 6	(1)
2 years in 10 earlier than	November 1	October 14	October 1	September 10	(1)
5 years in 10 earlier than	November 13	October 27	October 14	September 26	August 15

OCHOCO MOUNTAINS

Spring:					
1 year in 10 later than	April 18	May 10	June 4	June 28	(1)
2 years in 10 later than	April 11	May 3	May 29	June 22	(1)
5 years in 10 later than	March 29	April 20	May 15	June 10	June 27
Fall:					
1 year in 10 earlier than	October 14	September 26	September 5	August 14	(1)
2 years in 10 earlier than	October 23	October 5	September 14	August 23	(1)
5 years in 10 earlier than	November 8	October 22	September 29	September 9	July 17

[1] Accurate data cannot be determined for this temperature.

TABLE 11.—*Potential evapotranspiration and actual evapotranspiration*

Evapotranspiration	January	February	March	April	May	June	July	August	September	October	November	December	Year
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
Potential evapotranspiration	0.0	0.3	0.7	1.6	2.8	3.9	5.0	4.4	3.0	1.7	0.6	0.2	24.2
Actual evapotranspiration:													
Soil that has 2-inch water-holding capacity	0.0	.3	.7	1.5	2.2	1.6	.4	.4	.7	1.1	.6	.2	9.7
Soil that has 6-inch water-holding capacity	0.0	.3	.7	1.5	2.4	2.5	1.6	.9	.9	1.2	.6	.2	12.8

TABLE 12.—*Monthly and annual average number of growing degree-days at Antelope*

Base	January	February	March	April	May	June	July	August	September	October	November	December	Annual
40° F	16	24	82	201	396	575	834	775	592	312	77	23	3,907
50° F	(1)	(1)	5	38	141	282	524	475	294	87	2	(1)	1,848

[1] Less than one-half day.

Ochocos. Approximately 60 percent of these storms occurs in June, July, and August; 35 percent in May, September, and October; and the remaining 5 percent scattered through the other 6 months. These storms generally are not severe. Small hail commonly falls a few times each winter.

A true tornado has never been officially recorded in the survey area. Under certain conditions, dust devils build up to a height of several hundred feet late in spring and in summer. They sometimes cause superficial damage to awnings, carports, or other lightly built structures. These are not tornadoes, but sometimes they are erroneously reported as such.

Water Supply

Water supplies of the Trout Creek-Shaniko Area depend on many sources. The major geologic formations are not considered to be good sources of water. The Clarno Formation has many springs. These springs possibly result from lava resting on metamorphosed sediment. The fractured lava intercepts excess soil moisture accumulated during years of good rainfall. This excess moisture is then intercepted by the metamorphosed sediment and is forced to the soil surface again. This is called a perched water table and normally occurs where the precipitation is 11 to 12 inches or more or when years of high precipitation occur. The Dalles Formation yields few springs.

Wells drilled in either geologic formation are normally 300 to 600 feet deep. Production from these wells is generally insufficient for irrigation purposes.

Small irrigation dams and stock ponds provide limited water storage (fig. 16). Major streams, such as Trout, Cherry, Currant, and Willow Creeks, normally flow year round, but amounts are normally insufficient for flood irrigation after July.

Most household water comes from springs and for the most part contains minerals in nontoxic amounts. Calcium normally occurs in sufficient amounts to make the water somewhat hard.

Recreation

Over the years rock collecting has been a popular activity in this survey area. Agates and petrified wood have been used around most of the homesteads, in many places lining walks and flowerbeds or even used as rockeries. In addition to these uses, many commercial applications have been found for these rocks.

The survey area is characterized by many beautiful colors and kinds of rock. The world-famous "Plume Agate" at the Priday Agate Beds, ledge or seam agate in

Figure 16.—**Small stock pond on Simas cobbly silty clay loam, 10 to 35 percent slopes. Development of additional water sources is necessary to establish proper grazing patterns of livestock.**

lava, and petrified and opalized wood of the petrified forests are in the survey area.

The oldest known commercial agate beds in the central Oregon area are the Priday Agate Beds (fig. 17). There are several kinds of agate found in these beds, and they differ in hardness, color, and uses.

Much of the agate in the Priday Agate Beds and the surrounding area has come from what are called thunder eggs (fig. 18). There are many theories to explain how the eggs got here. One is that they were magma, from local volcanic vents, that was hurled through the air, thus cooling the outer layer. When they hit the ground, the interior flowed out and left a cavity. The cavity contained many designs in various colors left by escaping gases of oxides, iron, calcium, and other elements. The eggs were then covered by local sedimentary deposits. Silica and calcium in solution then filled the eggs in various shades of white to clear.

Most such eggs in the Priday Beds that contain plume and red moss are not thunder eggs, but rather occur in scoria, or gas-charged lava, that has filled in much the same way the thunder eggs did.

Nearly all thunder eggs occur north of Wilson Creek, east of Willowdale, and west of Ashwood.

Most of the ledge and seam agate formed during faulting of the rhyolites and sediments in the Clarno Formation. When looking for these materials, one should pay particular attention to the faulted areas that are capped by lava.

The petrified and opalized wood is mostly from redwood and deciduous hardwood trees. It is found in the clayey soils of the Clarno and John Day Formations.

***Figure 17.*—Priday Agate Beds, the oldest known commercial agate beds in central Oregon. These beds are commonly in areas or Simas cobbly silty clay loam, 10 to 35 percent slopes.**

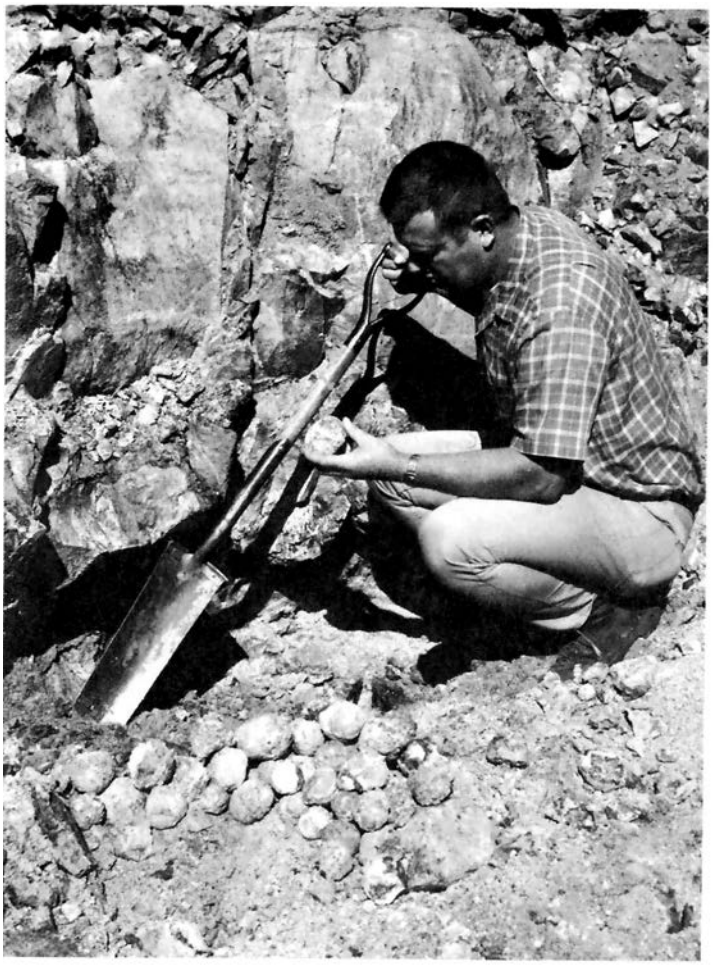

***Figure 18.*—Round agate-filled nodules called thunder eggs, designated Oregon State rock, are commonly found in areas of Simas cobbly silty clay loam, 10 to 35 percent slopes.**

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Base saturation. The degree to which material that has base-exchange properties is saturated with exchangeable cations other than

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 base of steep slopes.

Conglomerate. Rock composed of gravel and rounded stones cemented together by hardened clay, lime, iron oxide, or silica.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Crop year. The year in which a crop is to be harvested; in contrast to the fallow year, during which no crop is grown and the soil accumulates moisture for the crop year.

Cross-slope farming. Plowing, cultivating, planting, and harvesting across the general slope, but not on the contour as in contour farming.

Diagnostic horizon (soil). Combinations of specific soil characteristics that indicate certain classes of soils. Those that occur at the surface are called epipedons; those below the surface, diagnostic subsurface horizons.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Dryfarming. Production of crops that require some tillage in a subhumid or semiarid region, without irrigation. Usually involves use of periods of fallow, during which time enough moisture accumulates in the soil to allow production of a cultivated crop.

Duripan. A subsurface horizon that is cemented by silica.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Eluviation. The movement of material from one place to another within the soil, in either true solution or colloidal suspension. Soil horizons that have lost material through eluviation are said to be eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fallow. Cropland left idle in order to restore productivity, mainly through accumulation of water, nutrients, or both. Summer fallow is a common stage before cereal grain in regions of limited rainfall. The soil is tilled for at least one growing season to control weeds, to aid decomposition of plant residues, and to encourage the storage of moisture for the succeeding grain crop.

Frost-free season. The length of time between the average dates of the last occurrence in spring and the first in fall of a given temperature or lower. For this survey, frost-free season was calculated for temperatures of 28° and 32° F.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Granular. Roughly spherical firm small soil aggregates that may be either hard or soft, and without the distinct faces of blocky structure.

Gravel. Rounded and subrounded fragments of rocks greater than 2 millimeters but less than 3 inches in diameter. Refers to a mass of fragments.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive

characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

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.

Loam. Soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these. *fine,* less than 5 millimeters (about 0 2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0 6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Nodule, soil (concretions). Weakly silica and lime cemented to indurated spherical or elliptical soil masses.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. 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, are plant nutrients.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air Terms used to describe permeability are as follows. *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6 6 to 7 3
Very strongly acid	4 5 to 5.0	Mildly alkaline	7 4 to 7.8
Strongly acid	5.1 to 5 5	Moderately alkaline	7 9 to 8 4
Medium acid	5.6 to 6.0	Strongly alkaline	8 5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff. The removal of water by flow over the surface of the soil. The amount and rapidity of surface runoff are affected by the texture, structure, and porosity of the surface layer, by the vegetative covering, by the prevailing climate, and by the slope. The rate of surface runoff is expressed as follows: Ponded, very slow, slow, medium, rapid, and very rapid.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0 05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. A rock composed of particles deposited from suspension in water. The chief sedimentary rocks are conglomerate, from gravel; sandstone, from sand; shale, from clay; and limestone, from soft masses of calcium carbonate. There are many intermediate types Some wind-deposited sands have been consolidated into sandstone.

Shearing. A distortion, strain, or failure producing a change in form, usually without change in volume, in which parallel layers of a body are displaced in the direction of their line of contact.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Slope, soil. The incline of the surface of a soil. It is usually expressed in percentage of slope, which equals the number of feet of fall per 100 feet of horizontal distance.

Soil depth. The depth of the soil profile. The depth to which the roots of common plants penetrate; the depth to the underlying bedrock, hardpan, or other restrictive layer The depth classes used in this survey are: shallow 4 to 20 inches; moderately deep 20 to 40 inches; deep, over 40 inches.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes 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 characteristic of the soil are largely confined to the solum

Stones. Rock fragments greater than 10 inches in diameter if rounded, and greater than 15 inches along the longer axis if flat.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness The plowed layer.

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers

Vesicular. A soil structure characterized by round or egg-shaped cavities or vesicles

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.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. In referring to a capability unit, a range site, or a wildlife group, read the introduction to the section it is in for general information about its management. The two woodland suitability groups are described on page 50. Other information is given in tables as follows:

Acreage and extent, table 1, page 8.
Estimated yields, table 2, page 36.

Engineering uses of the soils, tables 5 and 6, pages 54 through 67.
Laboratory data, table 8, page 74.

Map symbol	Mapping unit	Page	Capability unit		Range site		Wildlife group	
			Symbol	Page	Name	Page	Number	Page
AgC	Agency loam, 1 to 2 percent slopes	7	IVe-2	35	Arid Rolling Hills	39	2	51
BaC	Bakeoven very cobbly loam, 2 to 20 percent slopes	9	VIIs	36	Scabland	45	1	51
BcC	Bakeoven-Condon complex, 2 to 20 percent slopes	9	VIIs	36	Biscuit-Scabland Complex	46	1	51
ByF	Boardtree and Yawkey gravelly loams, 20 to 70 percent slopes 1/	10	VIIe	35	Mixed Fir-Pine Forest	48	5	52
CnC	Condon silt loam, 2 to 12 percent slopes	10	IIIe-1	33	Rolling Hills	38	1	51
CoC	Condon-Bakeoven complex, 2 to 20 percent slopes	10	VIe	35	Biscuit-Scabland Complex	46	1	51
CrB	Court sandy loam, 1 to 8 percent slopes	11	IVe-1	34	Droughty Bottomland Fan	40	2	51
CtE	Curant and Tub silt loams, 8 to 40 percent slopes	11	VIe	35	North Exposure	43	4	51
CtF	Curant and Tub silt loams, 40 to 70 percent slopes	12	VIIe	35	Steep North	43	4	51
DaE	Day clay, 8 to 40 percent slopes	12	VIIe	35	Adobeland	46	4	51
DeE	Degner gravelly loam, 12 to 40 percent slopes	13	VIe	35	Shrubby North Exposure	44	4	51
DgC	Degner soils, 2 to 12 percent slopes	13	VIe	35	Shrubby Rolling Hills	40	4	51
DoE	Donnybrook stony loam, 10 to 40 percent slopes	14	VIe	35	Shrubby South Exposure	42	6	53
ErB	Era soils, 1 to 8 percent slopes	14	IVe-1	34	Sand Hills	45	2	51
ErE	Era soils, 8 to 40 percent slopes	15	VIe	35	Sandy North Exposure	45	2	51
GgE	Ginser gravelly silt loam, 12 to 40 percent slopes	15	VIe	35	North Exposure	43	4	51
GnF	Ginser very stony loam, 35 to 60 percent slopes	15	VIIs	36	Steep South	41	6	53
GpF	Ginser and Prag soils, 40 to 70 percent slopes	15	VIIe	35	Steep North	43	4	51
GrD	Gribble cobbly loam, 5 to 20 percent slopes	16	VIe	35	Shrubby Rolling Hills	40	4	51
HaE	Hankins cobbly loam, 15 to 50 percent slopes 2/	17	VIIe	35	Pine-Bunchgrass	48	5	52
LaC	Lamonta cobbly loam, 1 to 12 percent slopes	17	IVe-2	35	Shrubby Rolling Hills	40	2	51
LcE	Lickskillet very stony loam, 15 to 40 percent slopes	18	VIIs	36	Droughty South Exposure	41	1	51
LeF	Lickskillet extremely stony loam, 40 to 70 percent slopes	18	VIIs	36	Droughty Steep Sough	42	1	51
LgE	Lithgow and Sorf soils, 20 to 50 percent slopes	19	VIe	35	Droughty South Exposure	41	4	51
LhF	Lithgow very shaly loam, deep variant, 50 to 70 percent slopes	19	VIIs	36	Droughty Steep Sough	42	4	51

Map symbol	Mapping unit	Page	Capability unit: Symbol	Capability unit: Page	Range site: Name	Range site: Page	Wildlife group: Number	Wildlife group: Page
MaC	Madras loam, 1 to 12 percent slopes	20	IVe-2	35	Arid Rolling Hills	39	2	51
MbE	Madras soils, 12 to 40 percent slopes	20	VIIs	36	Droughty South Exposure	41	2	51
McD	McCoin loam, 5 to 20 percent slopes	20	IVe-2	35	Shrubby Rolling Hills	40	2	51
MmC	McMeen silt loam, 1 to 12 percent slopes	21	IIIe-1	33	Droughty Rolling Hills	39	4	51
MtB	Metolius sandy loam, 0 to 8 percent slopes	22	IVe-1	34	Droughty Bottomland Fan	40	3	51
Mx	Mixed alluvial land	22	IIIw-1	33	Semi-wet Bottom	47	3	51
Pa	Playas	22	IVw-1	35	(3/)	--	1	51
PrE	Prag cobbly loam, 5 to 40 percent slopes	23	VIe	35	North Exposure	43	4	51
PvE	Prag very stony loam, 12 to 50 percent slopes	23	VIIs	36	South Exposure	40	4	51
Ra	Rail clay	23	IVw-1	35	Moist Alkaline Bottom	47	3	51
Rh	Riverwash	24	VIIIw	36	(3/)	--	3	51
Rr	Rock outcrop-Rubble land complex	24	VIIIs	36	(3/)	--	1	51
Ru	Rough broken and stony land	24	VIIs	36	(3/)	--	4	51
SeF	Searles very stony loam, 35 to 65 percent slopes	25	VIIs	36	Juniper South Exposure	42	4	51
SlE	Simas cobbly silty clay loam, 10 to 35 percent slopes	26	VIe	35	Droughty South Exposure	41	4	51
SmF	Simas very stony clay loam, 35 to 70 percent slopes	26	VIIs	36	Droughty Steep South	42	4	51
SnE	Simas soils, 8 to 40 percent slopes	26	VIe	35	Droughty North Exposure	44	4	51
SoE	Sorf very stony loam, 5 to 40 percent slopes	27	VIIs	36	Droughty South Exposure	41	4	51
TgC	Tub gravelly clay loam, 1 to 12 percent slopes	27	IIIe-1	33	Droughty Rolling Hills	39	4	51
ThE	Tub cobbly clay loam, 12 to 40 percent slopes	27	VIe	35	South Exposure	40	4	51
TuF	Tub very stony clay loam, 40 to 70 percent slopes	28	VIIs	36	Steep South	41	4	51
TvD	Tub very stony soils, 1 to 20 percent slopes	28	VIIs	36	Droughty Rolling Hills	39	4	51
UtE	Utley shaly loam, 10 to 50 percent slopes	28	VIe	35	Shrubby North Exposure	44	6	53
VeE	Venator shaly loam, 10 to 40 percent slopes	29	VIe	35	Shrubby South Exposure	42	6	53
Wd	Willowdale loam	30	IIw-1	33	Moist Bottom	47	3	51
WrF	Wrentham-Rock outcrop complex, 35 to 70 percent slopes	30	VIIs	36	Steep North	43	1	51

1/ This soil placed in woodland suitability group 4r.

2/ This soil placed in woodland suitability group 5c.

3/ This land type not placed in a range site.

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