SOIL SURVEY OF CHELAN AREA, WASHINGTON

PARTS OF CHELAN AND KITTITAS COUNTIES

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

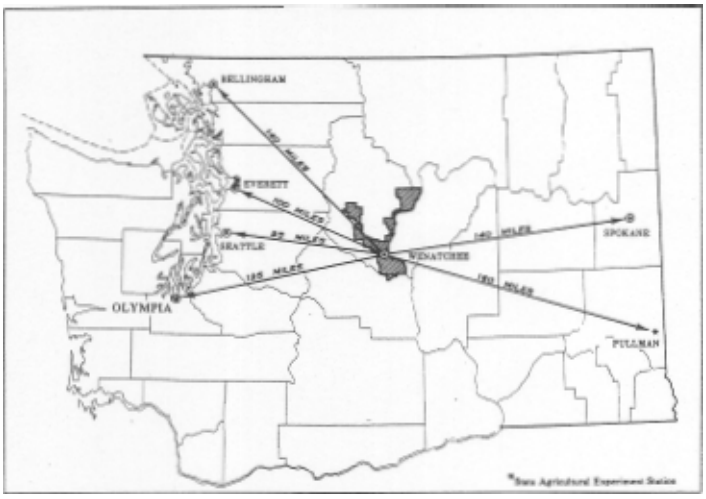

Figure 1.-Location of Chelan Area in Washington.

THE CHELAN AREA: PARTS OF CHELAN AND KITTITAS COUNTIES (called the Chelan Area in this soil survey) consists of slightly less than 20 percent of Chelan County and a very small part of Kittitas County. It is located mainly in the southeastern part of Chelan County, in north-central Washington (fig. 1).

Chelan Area consists of 297,310 acres in Chelan County and 5,000 acres in Kittitas County. Of this acreage, about 33,000 acres is irrigated land, 20,000 acres is dry cropland, 157,340 acres is rangeland, 76,000 acres is woodland, and 13,465 acres is water area.

In 1968 the survey area produced 6,500,000 boxes of apples and 60,000 bushels of wheat. Peaches, apricots, pears, cherries, grapes, oats, barley, and rye are also grown and sold commercially. Fairly large numbers of beef and dairy cattle are raised in the survey areas.

Crops were first produced near Wenatchee. The dry growing season made irrigation necessary for profitable crop production. As more people came into the Area, they settled farther up the Wenatchee Valley.

The deep soils of the high, rolling grasslands were the last to be cultivated, chiefly because of the lack of domestic water. They now, however, have become the most important soils for dryland wheat production.

Productivity of the woodland soils was low, and now many cutover areas are being converted to grass or managed woodland plots.

Annual precipitation in Chelan County ranges from 7 inches in the lower areas around Malaga to nearly 100 inches high in the Cascade Mountains. In the survey area annual precipitation ranges from 7 to 40 inches. The native vegetation reflects this rainfall. Needle-and-thread is the most important species around Malaga, deep-rooted perennials are the important species in the 8- to 12-inch precipitation zone farther up the valley, scattered Ponderosa pine and bunchgrass are found in the 12- to 20-inch precipitation zone, and mixed forests begin in the mountains, generally above the 20-inch zone.

The irrigated areas are mostly around Wenatchee and Chelan and in the valley extending from Wenatchee to Leavenworth. The soils in these areas are nearly all of alluvial origin, but around Chelan the soils formed in glacial till. Most of the soils in the forested mountains in the survey area formed in glacial till that is mixed with volcanic ash and pumice in the surface layer. Some of the upland areas escaped glaciation, and the soils in these areas formed in materials derived from weathered bedrock or loess.

The area between Wenatchee and Chelan should be a major-producing area for many years. The climate is ideally suited to apple production. Only a very small acreage is left in the survey area for expansion of orchards. Applications of fertilizer and irrigation water are needed for good growth of orchard crops. Damage to orchards during extremely cold winters, from frost in spring, insects, and diseases are major concerns.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in the Chelan Area, where they are located, and how they can be used. The soil scientists went into the Area knowing they likely would find many soils they had already seen and perhaps some they had not. They ob-

served 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 (7).

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. Wenatchee and Leavenworth, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness. or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Varelum silt loam, 3 to 15 percent slopes, is one of several phases within the Varelum 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. One such kind of mapping unit is shown on the soil map of the Chelan Area: the soil complex.

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. Anatone-Rock outcrop complex is an example.

Italic numbers in parentheses refer to Literature Cited, p. 102.

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. Alluvial land is a land type in this 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 kinds 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 kinds of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, 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 kind of 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 Chelan Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

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

drainage, and other characteristics that affect their management.

The soil associations in the Chelan Area are discussed in the following pages.

1. Burch-Cashmont association

Dominantly medium-textured and moderately coarse textured, nearly level to strongly sloping soils on terraces, alluvial fans, and foot slopes.

This association is on terraces and low, recent alluvial fans and foot slopes along the Columbia and Wenatchee Rivers and near other streams in the valley that extends from Wenatchee to Leavenworth (fig. 2). The major soils in the association formed mainly in valley fill and alluvium but have some loess and volcanic ash in the surface layer. Vegetation is bunchgrasses, forbs, and shrubs. Elevation ranges from 600 to 1,300 feet. Average annual precipitation is 8 to 20 inches, average annual air temperature is 47° to 52° F., and the frost-free season is 150 to 195 days.

This association makes up about 12 percent of the survey area. Burch soils make up about 32 percent of the association, Cashmont soils 23 percent, Pogue soils 11 percent, Beverly soils 9 percent, and Peshastin soils 8 percent. The remaining 17 percent is Brief, Cashmere, Cowiche, Ellisforde, Malaga, Quincy, Varelum, and Wenatchee soils.

Burch soils are on terraces along the Columbia River and in the valley that extends from Wenatchee to Leavenworth. They have a surface layer of dark grayish-brown loam or fine sandy loam, a subsoil of brown loam, and a substratum of yellowish-brown very fine sandy loam and loam.

Cashmont soils are on terraces, alluvial fans, and foot slopes along the Columbia River and in the valley between Wenatchee and Dryden. They have a surface layer of dark-gray sandy loam and gravelly sandy loam, a subsoil of dark-gray to brown sandy loam or gravelly sandy loam, and a substratum of pale-brown gravelly sandy loam.

Pogue soils are on glacial outwash terraces along the Columbia River and the lower Wenatchee River. Beverly soils are on low terraces along the Wenatchee and Entiat Rivers and in low areas near streams and other drainageways. Peshastin soils are on terraces along the Columbia River and in the valley that extends from Wenatchee to Leavenworth.

About 10,000 acres of this association is in orchards, about 4,000 acres is in irrigated hay and pasture, and most of the rest is in native vegetation and is used for grazing. Nearly all of the acreage used for orchard and alfalfa crops is irrigated. Irrigation water is obtained from wells, the Columbia and Wenatchee Rivers, and smaller streams.

This association provides habitat for some doves, pheasant, quail, and other upland game birds.

Figure 2.-Area of Burch-Cashmont association.

2. Chelan-Marge rum association

Dominantly gravelly or cobbly, medium-textured and moderately coarse textured, strongly sloping to steep soils on terraces and uplands

This association is on terraces and uplands, mainly along Lake Chelan (fig. 3). The major soils are well drained. They formed mainly in glacial till, loess, volcanic ash, and pumice and in places have boulders in the surface layer. Vegetation is bluebunch wheatgrass, bluegrass, needle-and-thread, sagebrush, bitterbrush, and scattered Ponderosa pine. Elevation ranges from 1,100 to 2,800 feet. Average annual precipitation is 9 to 15 inches, average annual air temperature is 48° to 50° F., and the frost-free season is 135 to 200 days.

This association makes up about 10 percent of the survey area. Chelan soils make up about 65 percent of the association, Margerum soils 15 percent, Supplee soils 10 percent, and Antilon soils 5 percent. The remaining 5 percent is Entiat, Thow, and Dinkelman soils.

Chelan soils are on dissected terraces near Lake Chelan. They have a surface layer of gray gravelly sandy loam, gravelly pumicey sandy loam, or cobbly sandy loam; a subsoil of gray and dark grayish-brown very gravelly pumicey sandy loam; and a substratum of pale-brown very gravelly pumicey sandy loam.

Margerum soils are on uplands slightly upslope from the Chelan soils. They have a surface layer of grayish-brown gravelly silt loam; a subsoil of pale-brown, grayish-brown, and light yellowish-brown gravelly silt loam; and a substratum of pale-brown silt loam.

Supplee soils are on terraces near the Columbia River. Antilon soils are on terraces adjoining Lake Chelan and mainly downslope from the Chelan soils.

About 6,000 acres of this association is in orchards, 6,000 acres is in wheat, and 2,000 acres is in irrigated alfalfa and grain. The rest is in native vegetation and is used mostly for grazing. All of the orchards and alfalfa are irrigated. The grain is grown in a summer fallow system. Irrigation water is obtained from the Columbia River, Lake Chelan, and numerous streams that drain into the lake.

This association is an important wintering area for deer, which come from higher elevations late in fall. It also provides habitat for pheasant, chukars, grouse, doves, and other upland game birds.

3. Thow-Nevine association

Dominantly gravelly or stony, medium-textured and moderately coarse textured, steep soils on uplands

This association is on outwash terraces and on glaciated and nonglaciated mountains on uplands. It consists mainly

Figure 3.-Area of Chelan-Margerum association. A Chelan gravelly sandy loam, pumiceous, in foreground, and a Margerum gravelly silt loam in wheat in background.

of well-drained soils that are gravelly or stony in some places. These soils formed in glacial till, ash, pumice, and loess. Vegetation is mainly ponderosa pine, pinegrass, and shrubs on outwash terraces and mixed trees and shrubs in the higher upland areas. Elevation ranges from 1,700 to 4,000 feet. Average annual precipitation is 16 to 40 inches, average annual air temperature is 43° to 48° F., and the frost-free season is 75 to 120 days.

This association makes up about 5 percent, of the survey area. Thow soils make up about 45 percent of the association, Nevine soils 30 percent, Goddard soils 15 percent, and Chiwawa soils 5 percent. The remaining 5 percent is Dinkelman and Margerum soils.

Thow soils are in the mountainous area near the Okanogan County line. They have a surface layer of light brownish-gray gravelly fine sandy loam or loam, a subsoil of pale-brown to brown very gravelly sandy loam, and a substratum of brown very gravelly sandy loam.

Nevine soils are on glaciated mountains in the Lake Wenatchee area. They have a surface layer of pale-brown sandy loam, a subsoil of pale-brown to very pale brown sandy loam, and a substratum of very pale brown gravelly sandy loam and gravelly loam.

Goddard and Chiwawa soils are on the low, glacial outwash terraces in the Lake Wenatchee area.

Nearly all of this association is in woodland and is used for timber production, recreation, wildlife habitat, and watershed. A small acreage is cleared and used for hay and pasture.

Deer, grouse, quail, bear, doves, and other wildlife inhabit this association. Some streams and lakes in this association provide fishing and boating. The Chiwawa and Goddard soils provide popular camping areas in summer, and several State camping parks are available. These soils also provide desirable sites for summer homes. The streams are used for irrigation and power generation farther downstream.

4. Brief-Leavenworth association

Dominantly moderately coarse textured, nearly level to strongly sloping soils on bottom lands, low terraces, and alluvial fans

This association is on bottom lands, low terraces, and alluvial fans (fig. 4). It consists mainly of well-drained, moderately coarse textured and coarse textured soils that

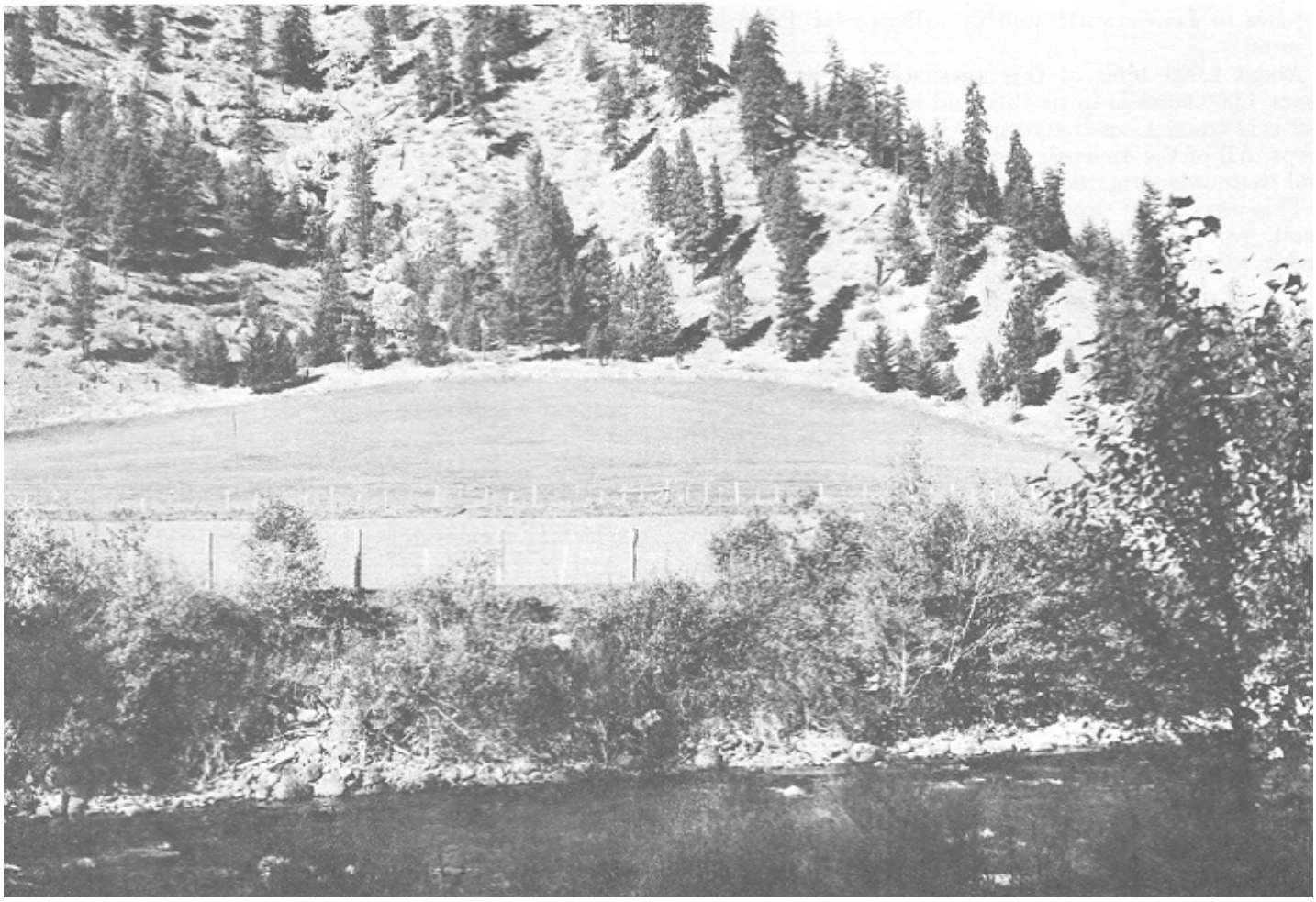

Figure 4.-Area of Brief -Leavenworth association. A Brief gravelly sandy loam across river is in alfalfa.

formed in alluvium but have some loess and volcanic ash in the surface layer. Vegetation is willow, alder, sedge, pinegrass, various forbs, rose, Douglas-fir, and ponderosa pine. Elevation ranges from 800 to 2,300 feet. Average annual precipitation is 15 to 30 inches, average annual air temperature is 43° to 50° F., and the frost-free season is 75 to 165 days.

This association makes up about 2 percent of the survey area. Brief soils make up about 45 percent of the association, Leavenworth soils 20 percent, Wintoner soils 20 percent, and Peoh soils 10 percent. The remaining 5 percent is Beverly, Cashmont, and Wenatchee soils.

Brief soils are on low terraces and fans, mostly along the Entiat River. They have a surface layer of grayish-brown gravelly sandy loam, a subsoil of pale-brown and grayish-brown gravelly sandy loam, and a substratum of brown to very pale brown very gravelly sandy loam.

Leavenworth soils are on bottom lands and low terraces near the Wenatchee River, mostly near the town of Leavenworth. They have a surface layer of dark-gray fine sandy loam or loamy sand, a subsoil of dark-gray fine sandy loam, and a substratum of dark-gray, stratified fine sandy loam.

Wintoner soils are on fans in Tumwater and Chumstick canyons. The poorly drained Peoh soils are in low-lying areas, mostly in the valley that extends from Wenatchee to Leavenworth and in valleys near Plain and Winton.

About 2,000 acres of this association is in orchards, about 1,000 acres is in pasture and hay, and most of the rest is in trees. A small acreage is in berries and vegetable crops. All of the orchards are irrigated. Some of the hay and pasture is irrigated.

This association provides habitat for doves, pheasant, quail, grouse, and other upland game birds. In summer and in winter, deer browse in unfenced orchards.

5. Anatone-Jumpe association

Dominantly medium-textured, strongly sloping to steep soils, many of which are shallow or stony, on uplands

This association is on the top and sides of ridges on mountainous uplands, south of Wenatchee, near the Kittitas-Chelan County line. The soils formed in glacial till and weathered basalt, but they have an admixture of loess and volcanic ash in the surface layer, and in some places bedrock is exposed. The major soils are well drained. Vegetation is mainly Douglas-fir, larch, lodgepole pine, ponderosa pine, white fir, pinegrass, sedge, some forbs, and low-growing shrubs. Elevation ranges from 2,700 to 5,500 feet. Average annual precipitation is 16 to 35 inches, average annual air temperature ranges from 40° to 46° F., and the frost-free season is 65 to 130 days.

This association makes up about 2 percent of the survey area. Anatone soils make up about 46 percent of the association; Jumpe soils 18 percent; Jumpe soils, red variant, 18 percent; and Loneridge soils 14 percent. The remaining 4 percent is Jumpe soils, thick surface variant.

Anatone soils have a surface layer of brown silt loam and a subsoil of brown very gravelly silt loam. They are underlain by basalt bedrock at a depth of about 14 inches.

Jumpe soils have a surface layer of grayish-brown silt loam, a subsoil of grayish-brown to light yellowish-brown cobbly silt loam, and a substratum of light yellowish-brown silt loam.

Jumpe soils, red variant, have a surface layer of brown loam and a subsoil of light grayish-brown cobbly loam.

This association is used for range, timber production, wildlife habitat, and watershed. Ranches are large, and carrying capacities are moderate to low. Water for livestock generally comes from small streams and from springs and ponds.

Elk and deer hunting is popular in this association because herds live in the areas the year round. Grouse, dove, quail, chukars, and other upland game are also present. The availability of food, cover, and water controls the movements and numbers of wildlife.

6. Bjork-Zen association

Dominantly medium-textured, steep soils underlain by bedrock at a depth of 20 to 40 inches; on uplands

This association is on terraces and side slopes in the hilly uplands that surround or are immediately south of Wenatchee (fig. 5). The soils are mainly well drained. They formed in loess or in material weathered from. sandstone or schist but have some loess and volcanic ash in the surface laver. Also, rock outcrops are in some places. Vegetation is bluebunch wheatgrass; bluegrass; bitterbrush; sagebrush; and, in places, scattered ponderosa pine. Elevation ranges from 1,000 to 3,000 feet. Average annual precipitation is 8 to 15 inches, average annual air temperature is about 50° F., and the frost-free season is 160 to 185 days.

This association makes up about 18 percent of the survey area. Bjork soils make up 39 percent of the association, Zen soils 26 percent, Cowiche soils 22 percent, and Yaxon soils 8 percent. The remaining 5 percent is Ritzville. Varelum, and Burch soils.

Bjork soils are on hilly uplands that surround Wenatchee. They have a surface layer of grayish-brown silt loam and a subsoil of brown and pale-brown clay loam and silt loam. They are underlain at a depth of about 26 inches by decomposing schist or sandstone bedrock.

Zen soils are on broad, rolling, high terraces south of Wenatchee. They have a surface layer of grayish-brown silt loam, a subsoil of brown silt loam, and a substratum of yellowish-brown heavy silt loam that is underlain by basalt bedrock at a depth of about 24 inches.

Cowiche soils are on hilly uplands that surround Wenatchee. Yaxon soils are on high terraces and hilly uplands, upslope from Cowiche soils.

The soils in nonirrigated areas of this association are used for grain, range, and wildlife habitat. The soils in irrigated areas are used for orchards, vineyards, hay, and pasture. Ranches are large, but their carrying capacities are low and water for livestock is limited. Springs and manmade, ponds are the primary sources of water.

Wildlife is mainly doves, chukars, pheasant, quail, and a few deer and elk.

Figure 5.-Area of Bjork-Zen association, in lower half of photo. A Bjork silt loam in foreground; Bjork-Rock outcrop complex, 25 to 65 percent slopes, eroded, on slope; a Yaxon silt loam on dryfarmed wheat fields above orchard on left side and near the middle; Cowiche soils in near background; and Cascade Mountains beyond.

7. Entiat-Dinkelman association

Dominantly moderately coarse textured, steep and very steep soils underlain by bedrock at a depth of 14 to 60 inches; on uplands

This association is on the top and sides of ridges in the foothills and on mountainous uplands (fig. 6). The soils formed in decomposing granodiorite and granite, but they have loess and a small amount of volcanic ash and pumice in the surface layer. Bedrock outcrops in some places. Vegetation is bluebunch wheatgrass, sedges, bluegrass, balsam root, lupine, bitterbrush, scattered Douglas-fir, and ponderosa pine. Elevation ranges from 1,000 to 4,000 feet. Average annual precipitation is 9 to 20 inches, average annual air temperature is 46° to 60° F., and the frost-free season is 120 to 165 days.

This association makes up 22 percent of the survey area. Entiat soils make up 65 percent of the association, Dinkelman soils 20 percent, and Tyee soils 10 percent. The remaining 5 percent is Ardenvoir and Morical soils.

Entiat soils are on ridgetops and hillsides along the Columbia River, from Wenatchee to the Okanogan County line. They have a surface layer of grayish-brown sandy loam, a subsoil of brown gravelly sandy loam, and a substratum of brown very gravelly sandy loam. Bedrock is at a depth of about 18 inches.

Dinkelman soils are on ridgetops and on the mountainous uplands, upslope from or north of the Entiat soils. They have a surface layer of grayish-brown gravelly sandy loam, a subsoil of grayish-brown gravelly sandy loam, and a substratum of light yellowish-brown gravelly sandy loam. Granodiorite bedrock is at a depth of 40 to 60 inches.

Tyee soils are on side slopes in mountainous areas, slightly upslope from Entiat soils.

The soils in this association are used for range, wildlife habitat, and limited production of timber. Ranches are medium in size and have moderate carrying capacities. The supply of water is somewhat limited. Streams and developed springs and ponds are the primary sources of water.

This association is a very important wintering area for deer, which come from the higher elevations late in fall. Some chukars, doves, grouse, pheasant, and other upland game birds also live on these soils. The availability of food, cover and water controls the movements and numbers of wildlife.

Figure 6.-Area of Entiat-Dinkelman association. An Entiat sandy loam in foreground and in grass area on slope, and Dinkelman-Rock outcrop complex, 0 to 60 percent slopes, on slope where trees are scattered.

8. Nard-Stemilt association

Dominantly medium-textured, steep and very steep soils underlain by bedrock below a depth of 40 inches; on uplands

This association is on ridgetops, foothills, and sides of terraces and on mountainous uplands. It consists mainly of well-drained soils that are cobbly or bouldery or that have rock outcrops in places. The soils formed in glacial till, weathered granodiorite, basalt, gneiss, schist, or sandstone bedrock. Their surface layer contains a mixture of loess and some volcanic ash. Vegetation is mainly ponderosa pine, Douglas-fir, bluebunch wheatgrass, pinegrass, bluegrass, lupine, balsam root, sedge. Idaho fescue, serviceberry, and ceanothus. Elevation ranges from 1,000 to 5,000 feet. Average annual precipitation is 12 to 35 inches, average annual air temperature ranges from 42° to 49° F., and the frost-free season is 70 to 190 days.

This association makes up about 23 percent of the survey area. Nard soils make up 36 percent of the association, Stemilt soils 24 percent, Colockum soils 12 percent, and Cle Elum soils 11 percent. The remaining 17 percent is Ardenvoir, Jumpe, Loneridge, Morical, Tronsen, Varelum, and Anatone soils.

Nard soils are on the mountainous uplands near Lake Wenatchee. They have a surface layer of grayish-brown silt loam, a subsoil of light yellowish-brown and pale-brown loam, and a substratum of pale-brown heavy silt loam.

Stemilt soils are on mountainous uplands, mostly south and west of Wenatchee to the Kittitas County line. They have a surface layer of grayish-brown silt loam, a subsoil of brown very cobbly silty clay loam, and a substratum of pale-brown very cobbly silty clay loam.

Colockum soils are on rolling upland terraces south of Wenatchee. Cle Elum soils are mostly on the sides of upland valleys extending from Cashmere to Leavenworth.

The soils in this association are used for range, timber production, wildlife habitat, and watersheds. Downslope from some of these soils are reservoirs of irrigation water. The forested soils are used for light grazing and for timber production. Streams, developed springs, and ponds are the primary sources of water.

Wildlife is mainly deer, elk, doves, grouse, chukars, quail, and a limited number of other game birds. The availability of food, cover, and water supplies controls the movements and numbers of wildlife. In this association are important wintering areas for deer that come from higher elevations late in fall.

9. Rock outcrop-Rock land-Terrace escarpments association

Dominantly steep and very steep to nearly vertical areas of rock outcrops, very shallow and shallow soils over rocks, and terrace breaks

This association consists mainly of areas of Rock outcrop, Rock land, and Terrace escarpments (fig. 7). Rock outcrop and Rock land are in all parts of the survey area. Terrace escarpments are in all parts except in the mountainous areas. Vegetation is mainly bunchgrass and scattered ponderosa pine and Douglas-fir. Elevation ranges from 600 to 4,500 feet. Average annual precipitation is 7 to 40 inches, average annual air temperature is 40° to 52° F., and the frost-free season is 75 to 195 days.

This association makes up 6 percent of this survey area. Rock outcrop makes up about 50 percent of the association, Rock land 18 percent, Terrace escarpments 18 percent, Alluvial land 5 percent, and Riverwash 5 percent. The remaining 4 percent is Beverly, Cle Elum, and Pogue soils.

Rock outcrop is more than 90 percent exposed bedrock. Rock land has a surface layer of grayish-brown sandy loam and a subsoil of brown fine sandy loam in 10 to 75 percent of the areas mapped and exposed bedrock in the rest.

Terrace escarpments have a surface layer of sandy, gravelly, and cobbly soil material that overlies glacial outwash.

Alluvial land is on low terraces adjacent to the Wenatchee and Columbia Rivers. Riverwash is along streams and rivers that flood.

This association is used mainly for grazing, wildlife habitat, recreation, and watersheds.

Wildlife population is very limited in this association. Areas of Terrace escarpments, Alluvial land, and Rock land provide habitat for some doves, pheasant, chukars, quail, and other upland game birds. The availability of food, cover, and water controls the movements and number of wildlife.

Descriptions of the Soils

This section describes the soil series and mapping units in the Chelan Area. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless

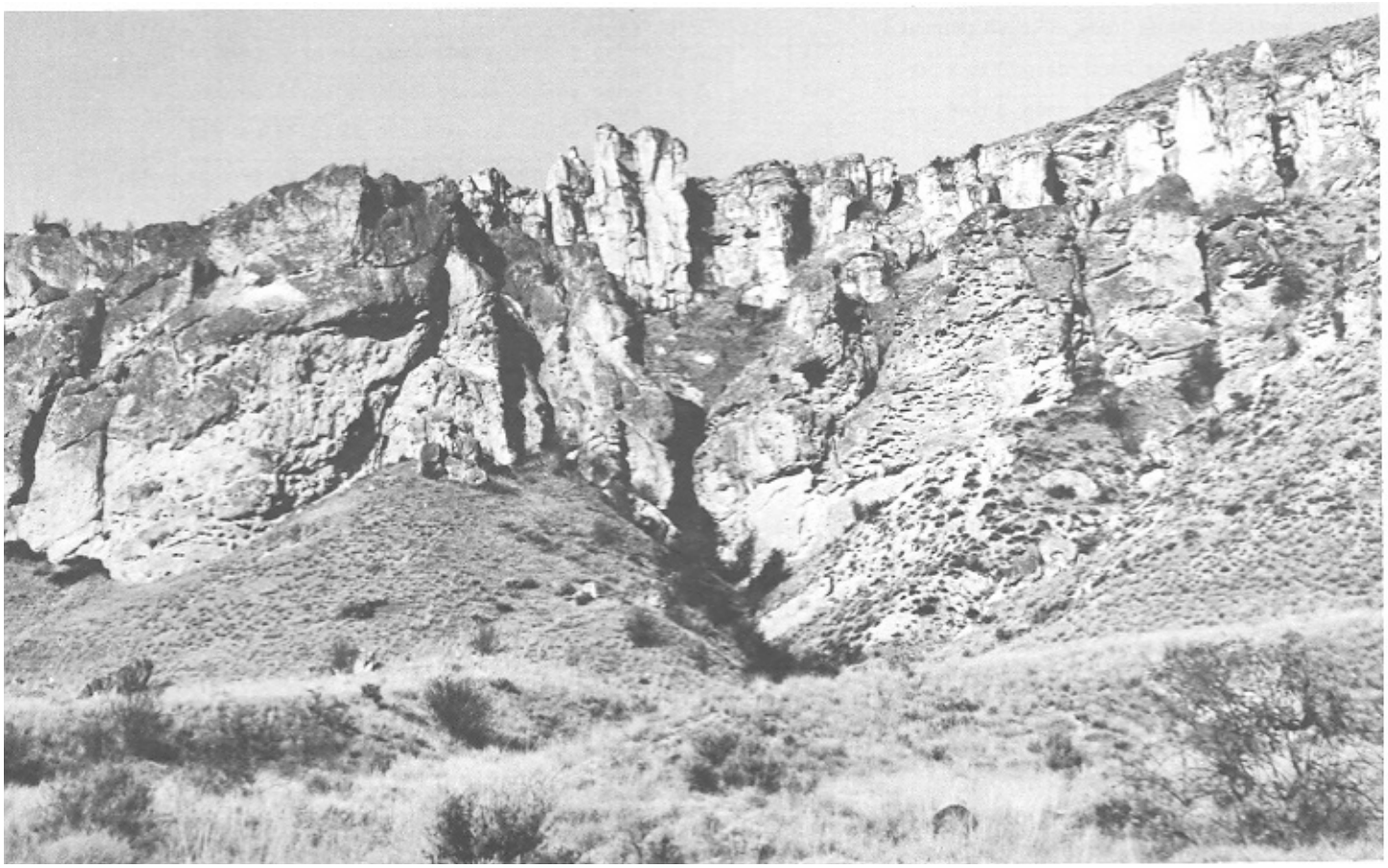

Figure 7.-An area of Rock outcrop in the Rock outcrop-Rock land-Terrace escarpments association.

it is 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.

A profile representative of each series is described in detail in the first mapping unit. This representative profile is for scientists, engineers, and others who need the highly technical soil interpretations.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Rock outcrop, for example, does not belong to a soil series, but nevertheless 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 is the capability unit, range site, orchard group, and woodland suitability group in which the mapping unit has been placed. The page for the description of each capability unit or other interpretative groups 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 (7).

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

Alluvial Land

Alluvial land (Ad) consists of moderately well drained areas of recent alluvium. It is on bottom lands and low terraces along the Wenatchee and Columbia Rivers. Slopes are 0 to 3 percent. Where this land type is not cultivated, vegetation is mainly blue wild rye, fern, sedge, mountain brome, aspen, alder, Douglas-fir, and willow. Elevation ranges from 650 to 1,900 feet. The average annual precipitation is 7 to 30 inches, the average annual air temperature is 46° to 51° F., and the frost-free season is 100 to 190 days. Alluvial land is associated mainly with Beverly, Burch, and Nevine soils.

The surface layer is generally grayish-brown fine sandy loam or silt loam about 8 to 12 inches thick. The underlying material is stratified, brownish or grayish loam to loamy sand to a depth of 46 inches or more. Thin lenses of gravel are in some places.

Runoff is ponded to very slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. Permeability is moderately rapid below a depth of 14 inches. Some areas are flooded once in about 5 years. In some places, a temporary water table occurs between depths of 2 and 4 feet in spring. The hazard of water erosion is none to slight. If this land type is irrigated, runoff is slow and the hazard of erosion is slight. The available moisture capacity is about 7 inches.

This land type is used mainly for pasture, hay, and orchards. Capability unit IIIw-1; woodland suitability group 2o1; not in a range site; orchard group 1.

Anatone Series

The Anatone series consists of well-drained, medium-textured soils that formed in loess and material weathered from basalt. These soils are on mountainous uplands. Slopes are 0 to 25 percent. Native vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, Idaho fescue, and low sagebrush. Elevation ranges from 3,500 to 5,500 feet. The average annual precipitation is 22 to 30 inches, average annual air temperature is 43° F., and the frost-free season is 110 to 130 days. These soils are associated mainly with Jumpe and Stemilt soils.

In a representative profile the surface layer is brown silt loam about 5 inches thick. The subsoil is brown very gravelly silt loam 9 inches thick. Basalt bedrock is at a depth of 14 inches.

Anatone soils are used for range and wildlife habitat.

Anatone-Rock outcrop complex, 0 to 25 percent slopes (AkD).-This complex is on broad, open ridgetops on mountainous uplands. It is 90 to 95 percent Anatone silt loam and 5 to 10 percent Rock outcrop. Average slope is 20 percent.

Representative profile, in an area 1,000 feet east and 500 feet north of southwest corner of sec. 1, T. 20 N., R. 20 E., Kittitas County:

A1-0 to 5 inches, brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; weak, medium, subangular blocky structure : slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; many very fine tubular pores ; mildly alkaline ; gradual, wavy boundary.

B2-5 to 14 inches, brown (7.5YR 4/2) very gravelly silt loam, dark brown (7.5YR 3/2) moist; weak, medium, sub-angular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic ; common fine roots ; many very fine tubular pores ; 60 percent gravel and cobblestones; mildly alkaline; abrupt, wavy boundary.

IIR-14 inches, basalt bedrock.

The A horizon ranges from 3 to 6 inches -in thickness. When moist, it has a chroma and a value of 2 or 3 and a hue of 5YR to 10YR, The B horizon is 8 to 12 inches thick and has weak to moderate, subangular blocky structure. When moist, it has a chroma and a value of 2 or 3 and a hue of 7.5YR or 5YR. The B horizon is more than 50 percent coarse fragments.

Included with this complex in mapping were small areas of Jumpe soils and areas of soils that are more than 20 inches deep over bedrock.

Permeability is moderate. Runoff is medium to rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is moderate to high. The available moisture capacity is 1.5 to 2.0 inches.

The soils in this unit are used mainly for range and wildlife habitat. Capability unit VIs-1; not in a woodland suitability group ; Shallow (S-3) or Very Shallow (C) range site ; not in an orchard group.

Antilon Series

The Antilon series consists of moderately well drained, moderately coarse textured soils that formed in pumice, volcanic ash, and loess underlain by lake sediment. These soils are on low terraces near Lake Chelan. Slopes are 0 to 25 percent. Where these soils are not cultivated, vegetation is mainly bluebunch wheatgrass, needle-and-thread, bitterbrush, and some sagebrush. Elevation ranges from 1,200 to 1,800 feet. The average annual precipitation is 10 to 15 inches, average annual air temperature is about 49° F., and the frost-free season is 185 to 200 days. These soils are associated mainly with Chelan, Supplee, and Margerum soils.

In a representative profile the surface layer is grayish-brown gravelly sandy loam about 10 inches thick. Below this layer is grayish-brown gravelly sandy loam 9 inches thick. The substratum is brown gravelly sandy loam 11 inches thick. It is underlain by lake sediment of silty clay loam at a depth of 30 inches.

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

The deep phases of Antilon soils are outside the range defined for the series with respect to the depth to sediment. This difference does not alter their usefulness or behavior.

Antilon gravelly sandy loam, 0 to 3 percent slopes (AnA).-This soil is on low terraces near Lake Chelan. Average slope is 2 percent.

Representative profile, in an area 500 feet west of east quarter corner of sec. 36, T. 28 N., R. 21 E., Chelan County:

Ap-0 to 10 inches, grayish-brown (10YR 5/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure ; soft, very friable, nonsticky and nonplastic ; many fine roots ; few fine tubular pores; about 20 percent pumice; mildly alkaline ; gradual, smooth boundary.

AC-10 to 19 inches, grayish-brown (10YR 5/2) gravelly sandy loam, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and nonplastic ; common

fine roots ; few fine tubular pores ; approximately 40 percent pumice ; mildly alkaline ; gradual, smooth boundary.

C-19 to 30 inches, brown (10YR 5/3) gravelly sandy loam, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and nonplastic; common fine roots; few fine tubular pores ; approximately 48 percent pumice ; moderately alkaline ; abrupt, smooth boundary.

IIB2tca-30 to 60 inches, light-gray (2.5Y 7/2) silty clay loam, light brownish gray (2.5Y 6/2) moist; uncrushed colors of olive gray (2.5Y 4/4) and light olive brown (2.5Y 5/4) moist; strong, medium, subangular blocky structure ; very hard, very firm, sticky and plastic ; few fine tubular pores ; thick continuous clay films ; strongly alkaline.

The A horizon ranges from 6 to 12 inches in thickness. Its dry and moist chroma is 1 or 2. Structure is weak, medium, granular, or the horizon is massive. This horizon is 20 to 40 percent pumice. The AC horizon ranges from 4 to 12 inches in thickness. It has a dry chroma of 1 or 2 and a moist chroma of 1 or 3. Structure is weak, medium, and granular, or the horizon is massive. This horizon is 35 to 50 percent pumice. The C horizon is 6 to 14 inches thick. It has a hue of 10YR or 2.5Y, a value of 5 to 7, and a chroma of 2 or 3. The IIB2tca horizon is several feet thick in places. It has a hue of 5Y or 2.5Y. a value of 5 to 7, and a chroma of 2 or 3. Its structure is platy or subangular blocky, or the horizon is massive. The content of clay is 28 to 35 percent. Reaction in this profile ranges from neutral to strongly alkaline. Depth to silty clay loam sediment is 20 to 38 inches.

Included with this soil in mapping were small areas of Chelan soils, some of which have granite gravel in the surface layer and some of which have slopes of more than 3 percent. Also included were a few somewhat poorly drained areas where depth to sediment is no more than 16 inches.

Permeability is slow in the sediment. Runoff is very slow, and the hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight. The available moisture capacity is about 10 inches. Roots can penetrate the full depth of the profile. The soil has a seasonal high water table at a depth of 2 to 4 feet in places.

This soil is used mainly for orchards.. It is also used for hay, pasture, range, and wildlife habitat. Capability unit IVe-1; not in a woodland suitability group ; Loamy (L-2) range site; orchard group 3.

Antilon gravelly sandy loam, 3 to 8 percent slopes (AnB).- This soil is on terraces. Included in mapping were small areas where slopes are less than 3 percent or more than 8 percent and some areas where the sediment is at a greater or lesser depth than in this soil.

Runoff is slow, and the hazard of erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate.

This soil is used mainly for orchards. It is also used for hay, pasture, range, and wildlife habitat. Capability unit IVe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 3.

Antilon gravelly sandy loam, 8 to 25 percent slopes (AnD).- This soil is on terraces. Included in mapping were small areas where slopes are less than 8 percent or more than 25 percent and some areas where the underlying sediment is at a depth greater than or less than 20 to 38 inches.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid to very rapid and the hazard of erosion is high to very high.

This soil is used mainly for orchards. It is also used for hay, pasture, range, and wildlife habitat. Capability unit VIe-1; not in a woodland suitability group ; Loamy (L-2) range site; orchard group 4.

Antilon gravelly sandy loam, deep, 0 to 3 percent slopes (AoA).-This soil is on terraces. It is similar to Antilon gravelly sandy loam, 0 to 3 percent slopes, except that sediment is at a depth of 40 to 60 inches.

Included with this soil in mapping were small areas of Chelan soils and some areas where sediment is at a lesser depth than in this soil.

The available moisture capacity is about 11 inches.

This soil is used mainly for orchards. Capability unit IIIe-1; not in a woodland suitability group ; Loamy (L-2) range site; orchard group 1.

Antilon gravelly sandy loam, deep, 3 to 8 percent slopes (AoB).-This soil is on terraces. It is similar to Antilon gravelly sandy loam, 0 to 3 percent slopes, except that depth to sediment is 40 to 50 inches.

Included with this soil in mapping were small areas where slopes are less than 3 percent or more than 8 percent and some areas where the sediment is at a lesser depth than in this soil.

Runoff is slow, and the hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate. The available moisture capacity is about 11 inches.

This soil is used mainly for orchards. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 1.

Ardenvoir Series

The Ardenvoir series consists of well-drained, medium-textured soils that formed in material weathered from schist and gneiss rock. The surface layer consists of a mixture of volcanic ash, loess, and a small amount of pumice. These soils are on mountainous uplands. Slopes are 25 to 65 percent. Native vegetation is Douglas-fir; ponderosa pine, serviceberry, spirea, ceanothus, and pinegrass. Elevation ranges from 2,000 to 5,000 feet. The average annual precipitation is 20 to 30 inches, average annual air temperature is about 47° F., and the frost-free season is 90 to 130 days. These soils are associated mainly with Tyee, Dinkelman, and Brief soils.

In a representative profile the surface layer is light brownish-gray loam 6 inches thick. The subsoil is pale-brown loam and heavy loam 21 inches thick. The substratum is pale-brown very gravelly sandy loam 16 inches thick. Fractured, weathered schist bedrock is at a depth of 43 inches.

Ardenvoir soils are used for woodland and wildlife habitat.

Ardenvoir loam, 25 to 65 percent slopes (ArF).- This soil is on mountainsides. Slopes average 50 percent.

Representative profile in an area one-half mile up logging spur road off Mills Canyon Road No. 2723, NW1/4NW1/4 sec. 34, T. 25 N., R. 20 E., Chelan County. This location is outside the Chelan Area. The soil profile is

representative of Ardenvoir soils mapped within the survey area:

O2-2 inches to 0, partly decomposed forest litter ; medium acid.

A1-0 to 6 inches, light brownish-gray (10YR 6/2) loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; soft, very friable, nonsticky and slightly plastic ; common fine, medium, and coarse roots ; common fine and medium pores ; slightly acid ; clear, irregular boundary.

B21-6 to 16 inches, pale-brown (10YR 6/3) loam, dark-brown (10YR 4/3) moist ; moderate, fine, subangular blocky structure ; hard, friable, slightly sticky and slightly plastic ; few fine and medium roots ; common fine and medium pores; thin patchy clay films on ped surfaces ; 10 percent gravel and stones ; medium acid ; gradual, wavy boundary.

B22-16 to 27 inches, pale-brown (10YR 6/3) heavy loam, dark brown (10YR 4/3) moist; moderate, medium, subangular blocky structure ; hard, friable, slightly sticky and slightly plastic few fine and medium roots ; few fine and medium pores ; thin patchy clay films on ped surfaces ; 20 percent gravel and stones ; medium acid ; gradual, wavy boundary.

IIC-27 to 43 inches, pale-brown (10YR 6/3) very gravelly sandy loam, dark brown (10YR 4/3) moist; massive; hard, friable, slightly sticky and slightly plastic ; few medium and coarse roots ; many medium and coarse pores ; 70 percent gravel and stones ; medium acid ; gradual, wavy boundary.

IIR-43 inches, fractured weathered schist rock.

The A horizon ranges from 4 to 10 inches in thickness. Value is 5 or 6, chroma is 2 or 3, and hue is 10YR. Moist chroma is 2 or 3. Structure in the A horizon ranges from weak or moderate to granular. The B horizon ranges from 17 to 27 inches in thickness. Value is 5 or 6, chroma is 3 or 4, and hue is 10YR. Structure in the B horizon is weak to moderate and fine to medium subangular blocky. This horizon has a few, thin, patchy clay films in places. Content of coarse fragments in the 10- to 40-inch zone ranges from 35 to 75 percent. The C horizon is 10 to 28 inches thick. It has a value of 5 or 6, a chroma of 3 or 4. and a hue of 10YR. It is very gravelly sandy loam or very gravelly loam and is stony in places. Depth to fractured, weathered schist bedrock ranges from 40 to 65 inches, but the average is 40 to 45 inches.

Included with this soil in mapping were small areas of Dinkelman and Tyee soils, some areas where the surface layer is gravelly, and some areas where bedrock is at a depth of less than 40 inches.

Permeability is moderate in the solum and moderately rapid in the substratum. Runoff is rapid to very rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is high to very high. The available moisture capacity is about 6 inches.

This soil is used mainly for woodland and wildlife habitat. Capability unit VIIe-1; woodland suitability group 5r1; not in an orchard group or range site.

Beverly Series

The Beverly series consists of well-drained, moderately coarse textured and coarse textured soils that formed in recent alluvium. These soils are on low terraces near streams. Slopes are 0 to 3 percent. Where these soils are not cultivated, vegetation is mainly bluebunch wheatgrass, needle-and-thread, bluegrass, and bitterbrush, sagebrush, and other shrubs. Elevation ranges from 600 to 850 feet. The average annual precipitation is 8 to 12 inches, average annual air temperature is 50° F., and the frost-free season is 150 to 185 days. These soils are associated mainly with Alluvial land and with Pogue and Brief soils.

In a representative profile the surface layer is grayish-brown fine sandy loam about 5 inches thick. Below this layer is 12 inches of grayish-brown fine sandy loam. The substratum is brown very gravelly sandy loam, 7 inches thick, that is underlain by gravel, cobblestones, and sand at a depth of 24 inches.

Beverly soils are used for apple and pear orchards, hay, pasture, and wildlife habitat.

Beverly fine sandy loam (Be).-This soil is on low terraces. Slopes average 1 percent.

Representative profile, in an area on bank of Wenatchee River, 220 feet west of cement blockhouse near line between secs. 31 and 32, T. 24 N., R. 19 E., Chelan County:

A1-0 to 5 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak, thin, platy structure ; very friable, soft, nonsticky and nonplastic ; many fine roots ; few fine tubular pores ; 10 percent gravel ; mildly alkaline ; abrupt, smooth boundary.

AC-5 to 17 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; massive ; very friable, soft, nonsticky and nonplastic ; many fine roots ; few fine tubular pores; 14 percent gravel ; mildly alkaline ; clear, smooth boundary.

C1-17 to 24 inches, brown (10YR 5/3) very gravelly sandy loam, dark brown (10YR 4/3) moist ; massive ; loose, soft, nonsticky and nonplastic ; common fine roots ; common fine tubular pores ; 70 percent gravel ; mildly alkaline ; abrupt, smooth boundary.

IIC2-24 inches, granite and basalt gravel that has a few cobblestones and a small amount of loamy coarse sand.

The A horizon ranges from 3 to 6 inches in thickness. It has a dry value of 4 or 5, a moist value of 3, and a dry and moist chroma of 2 or 3. This horizon has weak structure or is massive or single grain. The AC horizon is 8 to 12 inches thick. Its color, texture, and structure are the same as those of the A horizon. The C1 horizon is 3 to 8 inches thick. It has a dry value of 5 or 6, a moist value of 4, and a dry and moist chroma of 2 or 3. Texture is very gravelly sandy loam or loamy sand and structure is single grain, or the horizon is massive. The depth to lithologic discontinuity ranges from 14 to 26 inches.

Included with this soil in mapping were small areas of Pogue and Brief soils and some areas where the surface layer is gravelly or loamy fine sand.

Permeability is moderately rapid. Runoff is very slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight. Flooding occurs in places during periods of high water. The available moisture capacity is 4 to 5 inches. In some places a seasonal high water table is at a depth of 2 to 4 feet or more.

This soil is used mainly for orchards, hay, and pasture. Capability unit VIe-1; not in a woodland suitability group; Sandy Loam range site; orchard group 3.

Beverly gravelly fine sandy loam (Bf).-This nearly level soil is near streams on low terraces. Included in mapping were small areas of soils that are deeper than this soil, or that have a surface layer of fine sandy loam, loamy fine sand, or very gravelly loamy fine sand.

The available moisture capacity is about 4 inches.

This soil is used for orchards, hay, and pasture. Capability unit VIe-1; not in a woodland suitability group; Sandy Loam range site; orchard group 5.

Beverly very gravelly loamy fine sand (Bg).-This nearly level soil is on bottoms adjacent to streams. Included in mapping were small areas where the surface layer is loamy fine sand or gravelly fine sandy loam.

The available moisture capacity is 3.5 to 4 inches.

This soil is used mostly for pasture. Capability unit VIIe-1; not in a woodland suitability group; Sandy Loam range site ; orchard group 5.

Bjork Series

The Bjork series consists of well-drained, medium-textured soils that formed in material weathered from schist, gneiss, or sandstone. The surface layer contains some loess. These soils are on uplands. Slopes are 8 to 65 percent. The native vegetation is dominantly bluebunch wheatgrass and Idaho fescue and a few other grasses and forbs. Scattered stands or clumps of ponderosa pine and Douglas-fir are in places. Elevation ranges from 1,000 to 2,500 feet. The average annual precipitation is 9 to 14 inches, average annual air temperature is 50° F., and the frost-free season is 165 to 185 days. These soils are associated mainly with Cowiche, Cle Elum, Yaxon, and Ritzville soils.

In a representative profile the surface layer is grayish-brown and brown silt loam 12 inches thick. The subsoil is pale-brown clay loam 14 inches thick. Weathered schist bedrock is at a depth of 26 inches.

If Bjork soils are irrigated, they are used for orchards and vineyards or for hay and pasture. Nonirrigated areas are used for range, wildlife habitat, and recreation.

Bjork silt loam, 25 to 45 percent slopes (BkE).-This soil is on uplands. Slopes average 30 percent.

Representative profile, in an area 900 feet east of north quarter corner of sec. 16, T. 23 N., R. 20 E., Chelan County:

A11--0 to 4 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 fine roots ; many very fine tubular pores ; mildly alkaline ; clear, smooth boundary.

A12-4 to 12 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; moderate, fine, subangular blocky structure ; slightly hard, firm, slightly sticky and slightly plastic ; common fine roots ; many very fine tubular pores ; mildly alkaline ; clear, smooth boundary.

B2t-12 to 26 inches, pale-brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; moderate, medium, prismatic structure ; hard, very firm, sticky and plastic ; few fine roots ; many fine tubular pores ; few thin clay films on ped surfaces ; mildly alkaline ; gradual, wavy boundary.

R-26 inches, decomposing schist bedrock.

The A1 horizon ranges from 9 to 16 inches in thickness. Its color has a dry value of 4 or 5, a moist value of 3, and a dry and moist chroma of 2 or 3. Texture of this horizon is silt loam or loam, and structure is weak or moderate. The B horizon is 12 to 18 inches thick. Its color has a value of 5 to 7 and a chroma of 3 or 4. Texture of this horizon is heavy silt loam, clay loam, or sandy clay loam, and structure is moderate or strong. Clay films on ped surfaces are thin to moderately thick. Coarse fragments in the B2t horizon ranges from 0 to 15. Depth to schist, sandstone, or gneiss bedrock is 20 to 34 inches. Reaction is neutral to mildly alkaline throughout, but it becomes more alkaline as depth increases.

Included with this soil in mapping were small areas of Cowiche and Yaxon soils.

Permeability is moderately slow. Runoff is rapid to very rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is high to very high. The available moisture capacity is about 5 inches.

This soil is used mainly for range and wildlife habitat. Capability unit VIe-1; not in a woodland suitability group; Shallow (S-2) or North Exposure (N-1) range site ; orchard group 4.

Bjork silt loam, 8 to 15 percent slopes (BkC).-This soil is on foot slopes, terraces, and broad ridgetops on uplands. Included in mapping were small areas where slopes are less than 8 percent or more than 15 percent and some areas of soils that are deeper than this soil.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high.

This soil is used mainly for orchards, range, and wildlife habitat. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 3.

Bjork silt loam, 15 to 25 percent slopes (BkD).-This soil is on foot slopes, terraces, and broad ridgetops on uplands. Included in mapping were small areas where slopes are less than 15 percent or more than 25 percent and some areas of soils that are deeper than this soil.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mainly for orchards, range, and wildlife. Capability unit IVe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 4.

Bjork silt loam, 45 to 65 percent slopes (BkF).-This soil is on side slopes on uplands. Included in mapping were small areas where slopes are less than 45 percent and some areas of Rock outcrop.

Runoff is very rapid, and the hazard of water erosion is very high.

This soil is used mostly for range and wildlife habitat. Capability unit VIIe-1; Shallow (S-2) or North Exposure (N-1) range site; not in a woodland suitability group or an orchard group.

Bjork-Rock outcrop complex, 25 to 65 percent slopes, eroded (BoF2).-This complex is on side slopes on uplands. It consists of about 90 percent Bjork silt loam, 25 to 65 percent slopes, and 10 percent Rock outcrop. The outcrop is sandstone bedrock. It generally occurs in parallel lines but not necessarily on the horizontal. As much as 75 percent of the surface layer of Bjork silt loam has been removed by water erosion.

Included with this complex in mapping were small areas where slopes are less than 25 percent and some areas of soils that have a lower percentage of rock outcrop and are deeper to bedrock.

Runoff is very rapid, and the hazard of water erosion is very high.

This complex is used mostly for range and wildlife habitat. Capability unit VIIe-1; Shallow (S-2) or North Exposure (N-1) range site; not in a woodland suitability group or an orchard group.

Brief Series

The Brief series consists of well-drained, moderately coarse textured soils that formed in alluvium derived from granodiorite, granite, gneiss, schist, and sandstone. These soils are on low terraces near streams or on fans. Slopes are 0 to 25 percent. Where these soils are not cultivated, vegetation is mainly scattered ponderosa pine, snowberry, rose, oceanspray, pinegrass, and sedge. Elevation ranges from 1,100 to 1,500 feet. The average annual precipitation is 12 to 25 inches, average annual air temperature is 48° F., and the frost-free season is 150 to 165 days. These soils are associated mainly with Entiat, Beverly, and Dinkelman soils.

In a representative profile the surface layer is grayish-brown gravelly sandy loam and sandy loam 18 inches thick. The subsoil is pale-brown gravelly sandy loam 8 inches thick. The substratum is very pale brown very gravelly sandy loam that extends to a depth of 60 inches.

Brief soils are used for orchards, hay, pasture, and wildlife habitat.

Brief gravelly sandy loam, 3 to 8 percent slopes (BrB).-This soil is on low terraces near streams. Slopes average 6 percent.

Representative profile, in a road cut 1,320 feet west and 1,380 feet north of southeast corner of sec. 7, T. 26 N., R. 20 E., Chelan County. This location is outside the Chelan Area. The soil profile is representative of Brief soils mapped within the survey area:

Ap-0 to 6 inches, grayish-brown (10YR 5/2) gravelly sandy loam, very dark brown (10YR 2/2) moist; weak, thin, platy structure ; slightly hard, very friable, nonsticky and nonplastic ; common fine roots ; few fine tubular pores; 16 percent gravel; mildly alkaline; abrupt, smooth boundary.

A12-6 to 18 inches, grayish-brown (10YR 5/2) sandy loam, very dark brown (10YR 2/2) moist; weak, fine to coarse, prismatic structure ; common fine roots ; 14 percent gravel ; slightly hard, friable, nonsticky and nonplastic ; common medium tubular pores ; mildly alkaline ; abrupt, smooth boundary.

B2-18 to 26 inches, pale-brown (10YR 6/3) gravelly sandy loam, dark brown (10YR 4/3) moist; weak, coarse, prismatic structure breaking to weak, coarse, granular structure ; slightly hard, friable, nonsticky and nonplastic ; common fine roots ; few medium tubular pores ; 30 percent gravel ; mildly alkaline ; abrupt, wavy boundary.

C-26 to 60 inches, very pale brown (10YR 7/3) very gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, nonsticky and nonplastic ; few fine roots ; few fine tubular pores ; 70 percent gravel ; moderately alkaline.

The A horizon ranges from 10 to 22 inches in thickness. Its color has a dry value of 4 or 5, a moist value of 2 or 3, and a dry chroma of 1 or 2. Structure ranges from weak, thin, platy to weak, fine and coarse, prismatic or weak to moderate, fine, granular. The A horizon is stony in places. The B horizon is 6 to 10 inches thick. Its value is 4 to 6, and its chroma is 3 or 4. Structure ranges from weak to moderate and from fine to coarse. It is platy, prismatic, or granular. The solum ranges from 16 to 30 inches in thickness. The C horizon has a value of 5 to 7 and a chroma of 3 or 4. This horizon is 50 to 80 percent gravel. Reaction is mildly alkaline to moderately alkaline throughout. In places thin clay films are on ped surfaces.

Included with this soil in mapping were small areas of Beverly and Cashmere soils.

Permeability is moderately rapid. Runoff is slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate. The available moisture capacity is 5 to 6 inches.

The soil is used mainly for orchards, hay, and pasture. Capability unit IVe-1; woodland suitability group 2o1; not in a range site; orchard group 5.

Brief gravelly sandy loam, 0 to 3 percent slopes (BrA).-This soil is on low terraces near streams. Included in mapping were small areas where slopes are more than 3 percent.

Runoff is very slow, and the hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight. Flooding occurs occasionally in some areas in spring.

This soil is used for orchards, hay, and pasture. Capability unit IVe-1; woodland suitability group 2o1; not in a range site; orchard group 5.

Brief gravelly sandy loam, 8 to 15 percent slopes (BrC).-This soil is on low terraces near streams. Included in mapping were small areas where slopes are less than 8 percent or more than 15 percent and some areas where stones are on the surface.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high.

This soil is used for orchards, hay, and pasture. Capability unit IVe-1; woodland suitability group 2o1; not in a range site ; orchard group 5.

Brief gravelly sandy loam, 15 to 25 percent slopes (BrD).-This soil is on low terraces near steep valley sides and along fans, dissected drainageways, terrace breaks, and toe slopes.

Included with this soil in mapping were small areas where slopes are less than 15 percent and some areas where stones are on the surface.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used for orchards, hay, and pasture. Capability unit IVe-1; woodland suitability group 2o1; not in a range site ; orchard group 5.

Brief stony sandy loam, 0 to 25 percent slopes (BsD).-This soil is on low terraces, fans, and foot slopes near steep valley sides. It is similar to Brief gravelly sandy loam, 3 to 8 percent slopes, but the surface layer is stony.

Included with this soil in mapping were small areas where the surface layer is cobbly or gravelly.

Runoff is very slow to medium, and the hazard of water erosion is slight to moderate. If this soil is irrigated, runoff is slow to very rapid and the hazard of erosion is slight to very high. The available moisture capacity is 5.5 inches.

This soil is used for orchards, hay, and pasture. Generally, surface stones have been removed from cultivated

areas. Capability unit IVe-1; woodland suitability group 2o1; not in a range site; orchard group 5.

Burch Series

The Burch series consists of well-drained, medium-textured and moderately coarse textured soils that formed in valley fill, chiefly of sandstone origin. These soils are on terraces. Slopes are 0 to 45 percent. Where these soils are not cultivated vegetation is bluebunch wheatgrass. bluegrass, and big sagebrush. Elevation ranges from 700 to 1,200 feet. The average annual precipitation is 8 to 15 inches, average annual air temperature is 48° to 50° F., and the frost-free season is 165 to 190 days. These soils are associated mainly with Wenatchee, Cowiche, Cle Elum, and Beverly soils.

In a representative profile the surface layer is dark grayish-brown loam 8 inches thick. The subsoil is brown loam 18 inches thick. The substratum is yellowish-brown very fine sandy loam and loam that extends to a depth of 60 inches or more.

Burch soils are used mainly for the production of apples, pears, and soft fruit. They are among the most important fruit-producing soils in north-central Washington.

Burch loam, 0 to 3 percent slopes (BvA).-This soil is on terraces. Slopes average 2 percent.

Representative profile, in an area along dirt road 500 feet west of Princeton Road in NE1/4SW1/4sec. 33, T. 23 N., R. 20 E., Chelan County:

Ap-0 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, fine and medium ; granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; few fine tubular pores, vertically oriented ; neutral ; abrupt, smooth boundary.

B1-8 to 17 inches, brown (10YR 5/3) loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; many very fine tubular pores, vertically, horizontally, and diagonally oriented ; neutral ; gradual, wavy boundary.

B2-17 to 26 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak, medium, prismatic structure ; hard, friable, slightly sticky and slightly plastic ; common fine roots ; common very fine tubular pores, vertically, horizontally, and diagonally oriented ; neutral ; gradual, wavy boundary.

C1-26 to 36 inches, yellowish-brown (10YR 5/4) very fire sandy loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic ; common fine roots ; common very fine tubular pores, vertically and diagonally oriented ; neutral ; abrupt, smooth boundary.

C2-36 to 60 inches, yellowish-brown (10YR 5/4) loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic ; few fine roots ; many very fine tubular pores, vertically and diagonally oriented ; neutral.

The Ap horizon ranges from 5 to 9 inches in thickness. Its color has a moist value of 2 to 3 .5, a dry value of 4 or 5, and a moist or dry chroma of 1 to 3. The structure is weak, fine or medium, granular. The B horizon is 16 to 20 inches thick, It has a moist value of 3 or 4, a dry value of 4 to 6. and a moist or dry chroma of 2 to 4. The texture is dominantly loam, but it is silt loam or very fine sandy loam in places. This horizon has a weak, prismatic or blocky structure. The 0 horizon has the same range of color and texture as the B horizon. The C1 horizon is 8 to 12 inches thick.

Included with this soil in mapping were small areas of Beverly, Cowiche, and Cashmere soils and some areas where the surface layer is fine sandy loam.

Permeability is moderate. Runoff is very slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is slight. The available moisture capacity is about 10 to 12 inches. After several years of compaction by orchard implements, tillage pans form, which retard the movement of water.

The soil is used mainly for irrigated apple, pear, and soft-fruit orchards. Capability unit IIIc-1; not in a woodland suitability group or a range site; orchard group 1.

Burch loam, 3 to 8 percent slopes (BvB).-This soil is on terraces. Included in mapping were small areas where slopes are less than 3 percent or more than 8 percent. In most of these areas the surface layer is loam, but in places it is silt loam or very sandy loam.

Runoff is slow, and the hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate.

This soil is used mainly for irrigated apple, pear, and soft-fruit orchards. Capability unit IIIe-1; not in a woodland suitability group or a range site; orchard group 1.

Burch loam, 8 to 15 percent slopes (BvC).-This soil is on terraces. Included in mapping were small areas where slopes are less than 8 percent or more than 15 percent. In most of these areas the surface layer is loam, but in others it is silt loam or very fine sandy loam.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high.

The soil is used mainly for apple, pear, and soft-fruit orchards. Capability unit IIIe-1; not in a range site or a woodland suitability group; orchard group 1.

Burch loam, 15 to 25 percent slopes (BvD).-This soil is on terraces. Included in mapping were small areas where slopes are less than 15 percent or more than 25 percent. In most of these areas the surface layer is of loam, but in others it is silt loam or very fine sandy loam.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

The soil is used mainly for apple, pear, and soft-fruit orchards. Capability unit IVe-1; not in a range site or a woodland suitability group ; orchard group 2.

Burch fine sandy loam, 0 to 3 percent slopes (BuA).-This soil is on terraces. It is similar to Burch loam, 0 to 3 percent slopes, except that the surface layer is fine sandy loam. Included in mapping were small areas where slopes are more than 3 percent and areas where the subsoil is fine sandy loam.

The available moisture capacity is 10 to 11 inches. Tilth is good, and the soil is easy to work.

The soil is used mainly for apple, pear, and soft-fruit orchards. Capability unit IIIs-1; not in a range site or a woodland suitability group; orchard group 1.

Burch fine sandy loam, 3 to 8 percent slopes (BuB).-This soil is on terraces. It is similar to Burch loam, 0 to 3 percent slopes, except that the surface layer is fine sandy loam.

Included with this soil in mapping were small areas where slopes are less than 3 percent or more than 8 percent and some areas where the subsoil is fine sandy loam.

Runoff is slow, and the hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate. The available moisture capacity is 10 to 11 inches.

The soil is used mainly for apple, pear, and soft-fruit orchards. Capability unit IIIe-1; not in a range site or a woodland suitability group; orchard group 1.

Burch fine sandy loam, 8 to 15 percent slopes (BuC).-This soil is on terraces. It is similar to Burch loam, 0 to 3 percent slopes, except that the surface layer is fine sandy loam.

Included with this soil in mapping were small areas where slopes are less than 8 percent. or more than 15 percent and a few areas where the subsoil is fine sandy loam.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of eroison is high. The available moisture capacity is 10 to ii inches.

The soil is used mainly for apple, pear, and soft: fruit orchards. Capability unit IIIe-1; not in a range site or a woodland suitability-group. orchard group 1.

Burch fine sandy loam, 15 to 25 percent slopes (BuD).-This soil is on terraces. It is similar to Burch loam, 0 to 3 percent slopes, except that the surface layer is fine sandy loam.

Included with this soil in mapping were small areas where slopes are less than 15 percent or more than 25 percent and a few areas where the subsoil is fine sandy loam.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of water erosion is very high. The available moisture capacity is 10 to 11 inches.

This soil is used mainly for apple, pear, and soft-fruit orchards. Capability unit IVe-1; not in a range site or a woodland suitability group ; orchard group 2.

Burch fine sandy loam, 25 to 45 percent slopes (BuE).-This soil is on terraces. It is similar to Burch loam, 0 to 3 percent slopes, except that the surface layer is fine sandy loam.

Included with the soil in mapping were small areas where slopes are less than 25 percent and some areas where the subsoil is fine sandy loam.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high. The available moisture capacity is 10 to 11 inches.

The soil is used mainly for pasture. Some areas are in orchards. Capability unit IVe-1: not in a range site or a woodland suitability group; orchard group 2.

Cashmere Series

The Cashmere series consists of well-drained, moderately coarse textured soils that formed in alluvial and colluvial material, mainly of sandstone origin. These soils are on terraces, fans, and foot slopes. Slopes are 0 to 25 percent. Where these soils are not cultivated, vegetation is mainly big sagebrush, needle-and-thread, bluebunch wheatgrass, and bluegrass. Elevation ranges from 700 to 1,000 feet. The average annual precipitation is 8 to 12 inches, average annual air temperature is 48° to 50° F., and the frost-free season is 155 to 195 days. These soils are associated mainly with Cashmont, Burch, and Wenatchee soils.

In a representative profile the surface layer is dark grayish-brown sandy loam 9 inches thick. Below this layer is grayish-brown sandy loam 10 inches thick. The substratum is yellowish-brown sandy loam that extends to a depth of 60 inches or more.

Cashmere soils are used for orchards, hay, and pasture.

Cashmere sandy loam, 15 to 25 percent slopes (CaD).-This soil is on terraces and alluvial fans. Slopes average 20 percent.

Representative profile, in an area on west side of road in apple orchard 200 feet south of curve in road in NW1/4 NW1/4sec. 16, T. 23 N., R. 19 E., Chelan County:

Ap-0 to 9 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist ; weak, medium, granular structure; soft, very friable, nonsticky and nonplastic ; many fine roots ; few very fine tubular pores ; neutral ; clear, smooth boundary.

AC-9 to 19 inches, grayish-brown (10YR 5/2) sandy loam, dark brown (10YR 3/3) moist; weak, medium, prismatic structure ; soft, very friable ; nonsticky and nonplastic ; common fine roots ; few very fine tubular pores ; neutral ; gradual, smooth boundary.

C1-19 to 36 inches, yellowish-brown (10YR 5/4) sandy loam, dark brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic ; few fine roots ; very few fine tubular pores ; mildly alkaline ; gradual, smooth boundary.

C2-36 to 60 inches, yellowish-brown (10YR 5/4) coarse sandy loam, dark brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic ; few fine roots ; very few fine tubular pores ; mildly alkaline.

The Ap horizon ranges from 6 to 10 inches in thickness. It has a dry value of 3 or 4, a moist value of 2 or 3, and a dry chroma of 2. The A horizon is platy or granular in structure. The AC horizon is 8 to 10 inches thick. It has a dry value of 4 or 5, a moist value of 2 or 3, and a dry chroma of 2 or 3. It is massive, or structure is weak, medium, prismatic. The C horizon has a dry value of 4 or 5, a moist value of 3 or 4, and a dry chroma of 3. The darker values and chromas generally are in areas that have been irrigated for more than 50 years, and they have a high content of organic matter. The C horizon is massive, or it has weak, medium, prismatic structure. The C1 horizon is 15 to 20 inches thick. The lower part of the C horizon has thin lenses of gravelly loamy sand in places. The profile is as much as 15 percent gravel in places.

Included with this soil in mapping were areas of Cashmont and Burch soils.

Permeability is moderately rapid. Runoff is medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high. The available moisture capacity is 7 to 8 inches.

This soil is used mainly for orchards, hay, and pasture. Capability unit IVe-1; not in a range site or a woodland suitability group ; orchard group 2.

Cashmere sandy loam, 0 to 3 percent slopes (CaA).-This soil is on terraces and alluvial fans. Included in mapping were a few small areas where slopes are more than 3 percent.

Runoff is very slow, and the hazards of soil blowing and water erosion are none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight.

This soil is used mainly for orchards, hay, and pasture. Capability unit IIIe-1; not in a range site or a woodland suitability group ; orchard group 1.

Cashmere sandy loam, 3 to 8 percent slopes (CaB).-This soil is on terraces and alluvial fans. Included in mapping were a few small areas where slopes are less than 3 percent or more than 8 percent.

Runoff is slow. The hazards of soil blowing and water erosion are slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate.

This soil is used mainly for orchards, hay, and pasture. Capability unit IIIe-1; not in a range site or a woodland suitability group ; orchard group 1.

Cashmere sandy loam, 8 to 15 percent slopes (CaC).-This soil is on terraces and alluvial fans. Included in mapping were a few small areas where slopes are less than 8 percent or more than 15 percent.

Runoff is medium. The hazard of soil blowing is slight, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high.

This soil is used mainly for orchards, hay, and pasture. Capability unit IIIe-1; not in a range site or a woodland suitability group ; orchard group 1.

Cashmont Series

The Cashmont series consists of well-drained, moderately coarse textured soils that formed in alluvial and colluvial material of granite, gneiss, schist, and basalt origin. These soils are on terraces, alluvial fans, and foot slopes. Slopes are 0 to 25 percent. Where these soils are not cultivated, vegetation is mainly big sagebrush, bitterbrush, bluegrass, needle-and-thread, and bluebunch wheatgrass. Elevation ranges from 700 to 1,200 feet. The average annual precipitation is 8 to 12 inches, average annual air temperature is 48° to 52° F., and the frost-free season is 175 to 195 days. These soils are associated mainly with Burch, Cashmere, and Beverly soils.

In a representative profile the surface layer is dark-gray gravelly sandy loam that is 21 inches thick. The subsoil is brown gravelly sandy loam 7 inches thick. The
substratum is pale-brown gravelly sandy loam that extends to a depth of 60 inches.

Cashmont soils are used for orchards, vineyards, hay, pasture, and wildlife habitat.

Cashmont gravelly sandy loam, 8 to 15 percent slopes (CdC).-This soil is on terraces. Slopes average 10 percent.

Representative profile, in an area 90 feet east of farm road and 275 feet north of house in NE1/4SW1/4 sec. 21, T. 25 N., R. 17 E., Douglas County. This area has been irrigated for about 50 years. This location is immediately across the Columbia River from the Chelan Area. The soil profile is representative of Cashmont, soils mapped within the survey area:

Ap-0 to 8 inches, dark-gray (10YR 4/1) gravelly sandy loam, black (10YR 2/1) moist ; moderate, medium, granular structure ; soft, very friable. nonsticky and nonplastic ; many fine roots ; few fine tubular pores ; 20 percent gravel ; mildly alkaline ; clear, wavy boundary.

A12-8 to 21 inches, dark-gray (10YR 4/1) gravelly sandy loam, black (10YR 2/1) moist; moderate, medium, granular structure ; soft, very friable, nonsticky and nonplastic ; many fine roots ; few fine tubular pores ; 20 percent gravel ; mildly alkaline ; clear, wavy boundary.

B2-21 to 28 inches, brown (10YR 5/3) gravelly sandy loam, dark brown (10YR 3/3) moist; moderate, medium, granular structure ; soft, very friable, nonsticky and nonplastic ; common fine roots: common fine tubular pores ; 15 percent gravel ; mildly alkaline ; gradual, wavy boundary.

C-28 to 60 inches, pale-brown (10YR 6/3) gravelly sandy loam, dark brown (10YR 4/3) moist; moderate, medium, granular structure ; soft, very friable, nonsticky and nonplastic ; few fine roots ; common fine tubular pores ; 20 percent gravel ; mildly alkaline.

The A horizon ranges from 16 to 25 inches in thickness. Value is 4 or 5 and chroma is 2 or 3 when the soil is dry. Value is 2 or 3 and chroma is 1 or 2 when the soil is moist. Structure ranges from moderate, medium, granular to moderate, medium, subangular blocky. The A horizon is darker in areas that have been irrigated for more than 50 years than in other areas. The A horizon is gravelly or stony in places. The B2 horizon is 5 to 10 inches thick. Dry value is 5 or 6, and moist value is 3 or 4. Structure is moderate, medium, granular or subangular blocky. The C horizon has a dry value of 5 or 6 and a moist value of 3 to 5. Lenses of gravelly loamy sand are in this horizon in places. The content of gravel in the profile ranges from 15 to 35 percent, and the B2 and C horizons contain a few cobblestones in places. Reaction is neutral to mildly alkaline throughout.

Included with this soil in mapping were small areas of Cashmere and Burch soils and some areas where the surface layer is cobbly sandy loam or sandy loam.

Permeability is moderately rapid. Runoff is medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high. The available moisture capacity is about 5 inches.

This soil is used mainly for orchards. It is also used for pasture, range and wildlife habitat. Capability unit VIe-1; not in a woodland suitability group ; Sandy Loam range site ; orchard group 5.

Cashmont gravelly sandy loam, 15 to 25 percent slopes (CdD).-This soil is on terraces, fans, and foot slopes. Included in mapping were small areas where slopes are less than 15 percent or more than 25 percent and some areas where the surface layer is cobbly or nongravelly.

If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mainly for orchards. Some areas are in pasture. Capability unit VIe-1; not in a woodland suitability group ; Sandy Loam range site ; orchard group 5.

Cashmont sandy loam, 0 to 3 percent slopes (CcA).-This soil is on terraces and foot slopes. It is similar to Cashmont gravelly sandy loam, 8 to 15 percent slopes, except that it has a nongravelly surface layer.

Included with this soil in mapping were small areas where slopes are more than 3 percent and some areas where the surface layer is gravelly.

Runoff is very slow, and the hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight. The available moisture capacity is 6 to 7 inches.

This soil is used mostly for orchards. Capability unit IVe-1; not in a woodland suitability group ; Sandy Loam range site ; orchard group 1.

Cashmont sandy loam, 3 to 8 percent slopes (CcB).-This soil is on terraces and foot slopes. It is similar to Cashmont gravelly sandy loam, 8 to 15 percent slopes, except that the surface layer is nongravelly.

Included with this soil in mapping were small areas where slopes are less than 3 percent or more than 8 percent and some areas where the surface laver is gravelly.

Runoff is slow, and the hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate. The available moisture capacity is 6 to 7 inches.

This soil is used mostly for orchards. Capability unit IVe-1; not in a woodland suitability group;, Sandy Loam range site, orchard group 1.

Cashmont stony sandy loam, 0 to 25 percent slopes (CeD).-This soil is on terraces, fans, and foot slopes. It is similar to Cashmont gravelly sandy loam, 8 to 15 percent slopes, except that stones are throughout.

Included with this soil in mapping were small areas where the surface laver is gravelly or cobbly and some areas where the surface layer is nongravelly.

Runoff is very slow to medium, and the hazard of water erosion is slight to moderate. If this soil is irrigated, runoff is slow to very rapid and the hazard of erosion is slight to very high. The available moisture capacity is about 5 inches. This soil is used mainly for orchards. Where this soil is cultivated, surface stones have generally been removed. Capability unit VIe-1; not in a woodland suitability group; Sandy Loam range site; orchard group 5.

Chelan Series

The Chelan series consists of well-drained, moderately coarse textured soils that formed in pumice, volcanic ash, and loess over nonsorted, gravelly, cobbly, or bouldery deposits of ablation glacial till. These soils are on terraces. Where these soils are not cultivated, the vegetation is mainly bitterbrush, bluebunch wheatgrass, Idaho fescue, bluegrass, and big sagebrush. Elevation ranges from 1,200 to 1,800 feet. The average annual precipitation is 10 to 15 inches. average annual air temperature is about 50° F.. and the frost-free season is 180 to 200 days. These soils are associated mainly with Antilon, Margerum, and Entiat soils.

In a representative profile the surface: laver is gray gravelly sandy loam about 18 inches thick. Below this layer is dark grayish-brown gravelly sandy loam 17 inches thick. The substratum is pale-brown very gravelly sandy loam that extends to a depth of 60 inches.

Chelan soils are used for orchards, pasture, range, wildlife habitat, and small grain.

Chelan gravelly sandy loam, pumiceous, 3 to 8 percent slopes (ClB).-This soil is on terraces in the Lake Chelan area. Slopes average 6 percent.

Representative profile, in an area 175 feet south of green picker cabins below paved road in NE1/4NW1/4sec. 31, T. 28 N., R. 22 E., Chelan County:

Ap-0 to 6 inches, gray (10YR 5/1) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure ; slightly hard, very friable, slightly sticky and nonplastic ; many fine roots ; few fine tubular pores : 20 percent pumice ; mildly alkaline ; gradual, smooth boundary.

A1-6 to 18 inches, gray (10YR 5/1) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure; slightly hard, very friable, slightly sticky and nonplastic ; many fine roots ; few fine tubular pores ; 20 percent pumice ; mildly alkaline ; gradual, smooth boundary.

AC-18 to 35 inches, dark grayish-brown (10YR 4/2) gravelly sandy loam, dark brown (10YR 4/3) moist; weak, medium, prismatic structure ; slightly hard, very friable, slightly sticky and nonplastic ; common fine roots ; few fine pores ; 30 percent pumice ; mildly alkaline; gradual, wavy boundary.

C-35 to 60 inches, pale-brown (10YR 6/3) very gravelly sandy loam, brown (10YR 5/3) moist; massive ; soft, very friable, nonsticky and nonplastic ; few fine roots ; very few fine tubular pores ; 60 percent pumice ; moderately alkaline.

The A horizon ranges from 15 to 20 inches in thickness. It has a hue of 10YR or 2.5Y, a dry value of 4 or 5, a moist value of 2 or 3, and a dry and moist chroma of 1 or 2. It is cobbly or bouldery in places. The AC horizon is 15 to 20 inches thick. The C horizon is 10YR or 2.5Y in hue, 5 to 7 in value, and 2 or 3 in chroma. Its texture is gravelly sandy loam or very gravelly sandy loam that is as much as 30 percent cobblestones and stones in places. This soil material is 60 to 90 percent pyroclastics and is dominantly pumice throughout the profile.

Included with this soil in mapping were small areas of Antilon, Margerum, and Entiat soils and small areas of cobbly and bouldery soils.

Permeability is moderate to a depth of 35 inches and moderately rapid below. Runoff is slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion generally is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate. The available moisture capacity is 8 to 10 inches.

This soil is used mainly for orchard crops and small grain. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 1.

Chelan gravelly sandy loam, pumiceous, 0 to 3 percent slopes (ClA).-This soil is on terraces. Included in mapping were small areas where slopes are more than 3 percent and some areas of soils that contain granite gravel.

Runoff is very slow. and the hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight. The available moisture capacity is about 8 to 10 inches.

This soil is used mainly for orchard crops. Capability unit IIIe-1; not in a woodland suitability group ; Loamy (L-2) range site; orchard group 1.

Chelan gravelly sandy loam, pumiceous, 8 to 15 percent slopes (ClC).-This soil is on dissected terraces. Included in mapping were, small areas where slopes are less than 8 percent or more than 15 percent and some areas where the subsoil is clay loam.

Runoff is medium, and the hazard of water erosion is

moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high.

This soil is used mainly for orchard crops, and small grain. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 1.

Chelan gravelly sandy loam, pumiceous, 15 to 25 percent slopes (ClD).-This soil is on dissected terraces. Included in mapping were small areas where slopes are less than 15 percent or more than 25 percent and some areas where the subsoil is clay loam.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mainly for orchard crops and small grain. Capability unit IVe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 2.

Chelan gravelly sandy loam, pumiceous, 25 to 45 percent slopes (ClE).-This soil is on dissected terraces. Included in mapping were small areas where slopes are less than 25 percent.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mainly for range and wildlife habitat. A few areas are used for orchards. Capability unit VIe-1; not in a woodland suitability group; Shallow (S-2) or North Exposure (N-1) range site; orchard group 2.

Chelan cobbly sandy loam, 8 to 15 percent slopes (ChC).-This soil is on terraces. It is similar to Chelan gravelly sandy loam, pumiceous, 3 to 8 percent slopes, except that cobblestones are on the surface and throughout the soil. The cobblestones are about 6 inches in diameter and make up about 30 percent of this soil (fig. 8).

Included with this soil in mapping were small areas where slopes are less than 8 percent or more than 15 percent and some areas that contain no cobblestones.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high. The available moisture capacity is about 7 to 8 inches.

This soil is used mainly for pasture and wildlife habitat. Some areas are in orchards. Capability unit VIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 5.

Chelan cobbly sandy loam, 25 to 45 percent slopes (ChE).-This soil is on terraces. It is similar to Chelan gravelly sandy loam. pumiceous, 3 to 8 percent slopes, except that cobblestones are on the surface and throughout the soil. The cobblestones are about 6 inches in diameter and make up 30 percent of this soil.

Included with this soil in mapping were small areas where slopes are less than 25 percent and some small areas of soils that contain no cobblestones.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high. The available moisture capacity is about 7 to 8 inches.

This soil is used mainly for range and wildlife habitat. Capability unit VIe-1; not in a woodland suitability group; Shallow (S-2) or North Exposure (N-1) range site ; orchard group 5.

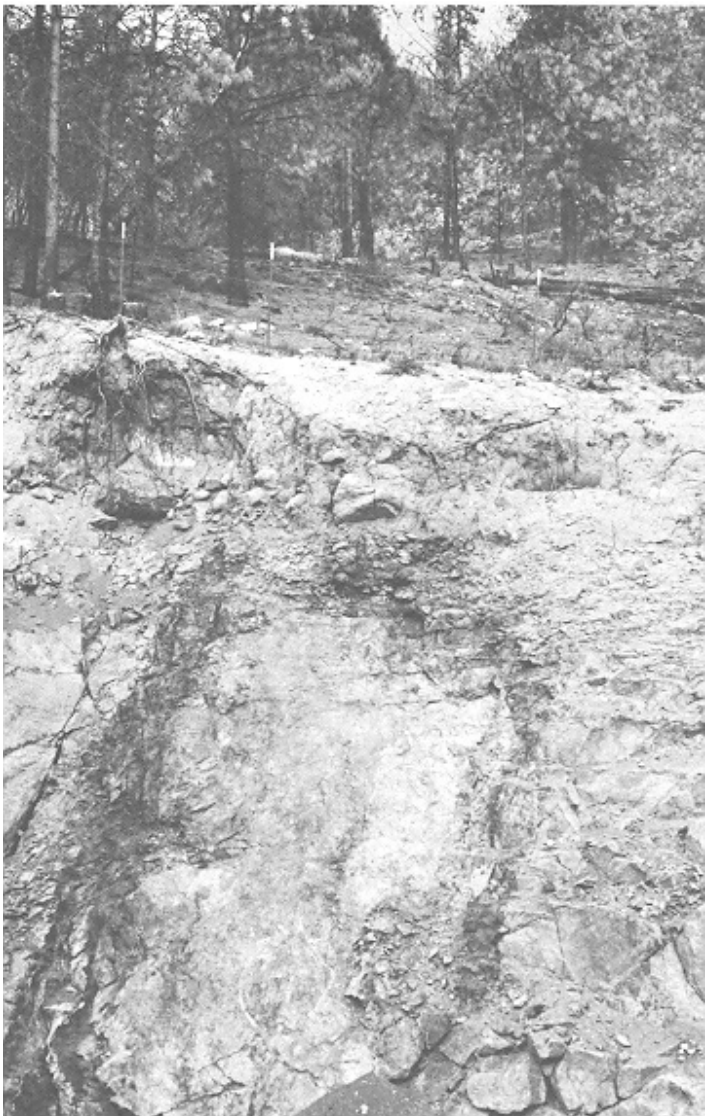

Figure 8.-Area of Chelan cobbly sandy loam, 8 to 15 percent slopes.

Chelan bouldery sandy loam, 0 to 25 percent slopes (CkD).-This soil is on terraces. It is similar to Chelan gravelly sandy loam, pumiceous, 3 to 8 percent slopes, except that boulders are on the surface and throughout the soil. The boulders average 3 feet in diameter, but some are as much as 10 feet. They cover about 0.1 percent of the surface.

Included with this soil in mapping were small areas where slopes are more than 25 percent and some small areas of soils that contain no boulders.

Runoff is slow to medium, and the hazard of water erosion is slight to moderate. If this soil is irrigated, runoff is medium to very rapid and the hazard of erosion is moderate to very high. The available moisture capacity is about 7 to 8 inches.

This soil is used mostly for pasture and orchards. Capability unit VIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 5.

Chelan bouldery sandy loam, 25 to 45 percent slopes (CkE).-This soil is on dissected terraces. It is similar to Chelan gravelly sandy loam, pumiceous, 3 to 8 percent slopes, except that boulders are on the surface and throughout the soil. The boulders average 3 feet in diameter, but some are as much as 10 feet in diameter. They cover about 0.1 percent of the surface.

Included with this soil in mapping were small areas where slopes are less than 25 percent and some small areas of soils that contain no boulders.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high. The available moisture capacity is about 7 to 8 inches.

This soil is used mostly for range and wildlife habitat. Capability unit VIe-1; not in a woodland suitability group; Shallow (S-2) or North Exposure (N-1) range site; orchard group 5.

Chelan gravelly sandy loam, 3 to 8 percent slopes (CgB).-This soil is on terraces. It is similar to Chelan gravelly sandy loam, pumiceous, 3 to 8 percent slopes, except that the surface layer is about 20 percent granite gravel, and a smaller amount of granite gravel is in the rest of the soil.

Included with this soil in mapping were small areas where slopes are less than 3 percent or more than 8 percent and some small areas of soils that have no gravel.

Runoff is slow, and the hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate. The available moisture capacity is about 7 to 8 inches.

This soil is used mainly for orchards. Capability unit VIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 5.

Chelan gravelly sandy loam, 8 to 15 percent slopes (CgC).-This soil is on dissected terraces. It is similar to Chelan gravelly sandy loam, pumiceous, 3 to 8 percent slopes, except that the surface layer is about 20 percent granite gravel and a smaller amount of granite gravel is in the rest of the soil.

Included with this soil in mapping were small areas where slopes are less than 8 percent or more than 15 percent and some small areas of soils that have no gravel.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high. The available moisture capacity is about 7 to 8 inches.

This soil is used mainly for orchards. Capability unit VIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 5.

Chelan gravelly sandy loam, 15 to 25 percent slopes (CgD).-This soil is on terraces. It is similar to Chelan gravelly sandy loam, pumiceous. 3 to 8 percent slopes, except the surface layer is about 20 percent granite gravel, and a smaller amount of granite gravel is in the rest of the soil.

Included with this soil in mapping were small areas where slopes are less than 15 percent or more than 25 percent and some small areas of soils that contain no gravel.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high. The available moisture capacity is about 7 to 8 inches.

This soil is used mainly for orchards. Some areas are in pasture. Capability unit VIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 5.

Chelan gravelly sandy loam, 25 to 45 percent slopes (CgE).-This soil is on terraces. It is similar to Chelan gravelly sandy loam, pumiceous, 3 to 8 percent slopes, except that the surface layer is about 20 percent granite gravel, and a smaller amount of granite gravel is in the rest of the soil.

Included with this soil in mapping were small areas where slopes are less than 25 percent and some small areas of soils that have no gravel.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high. The available moisture capacity is about 7 to 8 inches.

This soil is used mainly for range and wildlife habitat. Capability unit VIe-1; not in a woodland suitability group; Shallow (S-2) or North Exposure (N-1) range site; orchard group 5.

Chiwawa Series

The Chiwawa series consists of well-drained, moderately coarse textured soils that formed in pumice, volcanic ash, and loess over gravelly glacial outwash. These soils are on terraces in the Lake Wenatchee area. Slopes are 0 to 3 percent. Native vegetation is mainly ponderosa pine, Douglas-fir, pinegrass, spirea, and oceanspray. Elevation ranges from 1,700 to 2,500 feet. The average annual precipitation is 25 to 40 inches, average annual air temperature is about 45° F., and the frost-free season is 75 to 120 days. These soils are associated mainly with Nevine, Nard, and Goddard soils.

In a representative profile the surface layer is grayish-brown gravelly fine sandy loam 2 inches thick. The subsoil is brown and pale-brown gravelly fine sandy loam 23 inches thick. The substratum is pale-brown gravelly fine sandy loam 20 inches thick. Glacial outwash gravel, cobblestones, and sand underlie these soils at a depth of 45 inches.

Chiwawa soils are used mainly for woodland and wildlife habitat. A small acreage is cleared and is in hay and pasture.

Chiwawa gravelly fine sandy loam, 0 to 3 percent slopes (CmA).-This soil is on terraces. Slopes average 2 percent.

Representative profile, in an area 2 miles west of Chiwawa River, 1,320 feet north of south quarter corner of sec. 25. T. 27 N., R. 17 E. Chelan County. This location is outside the Chelan area. The soil profile is representative of Chiwawa soils mapped within the survey area:

O1-4 to 2 inches, undecomposed duff of needles, twigs, cones, and grass.

O2-2 inches to 0, decomposed and partially decomposed needles, twigs, and cones.

A2-0 to 2 inches, grayish-brown (10YR 5/2) gravelly fine sandy loam, very dark grayish brown (10YR 3/2) moist ; weak, fine, granular structure ; soft, very friable, nonsticky and nonplastic ; common fine roots ; few fine tubular pores ; 20 percent pumice ; medium acid ; abrupt, broken boundary.

B21ir-2 to 4 inches, brown (10YR 5/8) gravelly fine sandy loam, dark brown (10YR 3/3) moist; weak, fine, subangular blocky structure ; soft, very friable, nonsticky and nonplastic ; common fine roots ; very few fine tubular pores; 20 percent pumice; few pebbles and cobblestones ; slightly acid; abrupt, smooth boundary.

B22-4 to 8 inches, pale-brown (10YR 6/3) gravelly fine sandy loam, dark brown (10YR 4/3) moist; weak, fine, subangular blocky structure; soft, very friable, nonsticky and nonplastic ; common fine and medium roots ; few fine and medium tubular pores ; 20 percent pumice ; few pebbles and cobblestones ; slightly acid ; gradual, smooth boundary.

B23-8 to 25 inches, pale-brown (10YR 6/3) gravelly fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak, granular structure ; soft, very friable, nonsticky and nonplastic; few fine roots; few fine and medium tubular pores ; 25 percent pumice ; few pebbles and cobblestones ; mildly alkaline ; gradual, smooth boundary.

C1-25 to 45 inches, pale-brown (10YR 6/3) gravelly fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak, fine, granular structure ; soft, very friable, nonsticky and nonplastic ; few fine roots ; few fine and medium tubular pores; 20 percent pumice ; 10 percent gravel and cobblestones; mildly alkaline; abrupt, wavy boundary.

IIC2-45 to 60 inches, water-washed gravel, cobblestones, and sand.

The A2 horizon ranges from 0 to 2 inches in thickness. Dry value is 4 or 5, moist value is 3. and dry and moist chroma is 1 or 2. The structure is weak, granular or platy. The A horizon is slightly acid or medium acid. The Bir horizon is 1 to 3 inches thick. It has a dry value of 4 or 5, a moist value of 3, and a dry and moist chroma of 3. Its texture is gravelly fine sandy loam or gravelly sandy loam. The gravel consists of pumice. The structure in the Bir horizon is weak, blocky or granular, and reaction is slightly acid or neutral. The B22 and B23 horizons have a combined thickness of 18 to 25 inches. They have a dry value of 5 to 7, a moist value of 4, and a dry and moist chroma of 3 or 4. The texture is gravelly sandy loam or gravelly fine sandy loam ; the gravel consists dominantly of pumice. The structure is weak, blocky or granular. Reaction in these horizons is slightly acid to mildly alkaline. The C horizon has the same range in color and texture as the B horizon. It is massive or has a weak structure, and it is neutral to mildly alkaline. The C1 horizon ranges from 15 to 30 inches in thickness. The ITC horizon consists of outwash gravel, cobblestones, and sand, and it contains little or no pumice.

Included with this soil in mapping were small areas of Nevine and Goddard soils and some. areas of soils that are steeper than this soil.

Permeability is moderate to a depth of 45 inches and very rapid below. Runoff is very slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is none to slight. The available moisture capacity is 7 to 9 inches.

This soil is used mainly for woodland and wildlife habitat. Capability unit IVe-1; woodland suitability group 3o2; not in an orchard group or a range site.

Cle Elum Series

The Cle Elum series consists of well-drained, medium-textured soils that formed in loess and weathered sandstone on uplands. Slopes are 25 to 65 percent. Where these soils are not cultivated, vegetation is mainly ponderosa pine and Douglas-fir with an understory of a variety of grasses, forbs, and shrubs. Elevation ranges from 1,000 to 2,500 feet. The average annual precipitation is 20 to 35 inches, average annual air temperature is 46° F., and the frost-free season is 160 to 185 days. These soils are associated mainly with Burch, Cowiche, and Varelum soils.

In a representative profile the surface layer is gray and light brownish-gray silt loam 10 inches thick. The subsoil is pale-brown silt loam and clay loam 24 inches thick. Disintegrating sandstone underlies these soils at a depth of 34 inches.

Cle Elum soils are used for woodland, range, and wildlife habitat. A small acreage is in orchards.

Cle Elum silt loam, 25 to 45 percent slopes (CnE).-This soil is on uplands. Slopes average 30 percent.

Representative profile, in an area on south side of farm road 100 feet up from junction with paved road in wooded area that faces north, in SW1/4NW1/4 sec. 27, T. 24 N., R. 18 E., Chelan County.

O1-1/2 inch to 0, duff of undecomposed needles, twigs, and cones.

A1-0 to 4 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; moderate, fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; few fine tubular pores ; mildly alkaline ; abrupt, smooth boundary.

A3-4 to 10 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate, fine, subangular blocky structure ; slightly hard, friable, sticky and slightly plastic ; many fine roots ; many fine tubular pores ; neutral ; abrupt, smooth boundary.

B1-10 to 15 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; moderate, medium, subangular blocky structure ; slightly hard, firm, sticky and slightly plastic ; common fine roots ; many very fine tubular pores ; neutral ; abrupt, smooth boundary.

B2t-15 to 21 inches, pale-brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist ; strong, medium, subangular blocky structure ; hard, very firm, sticky and plastic ; common fine roots ; many very fine tubular pores ; few thin clay films on faces of peds ; slightly acid; abrupt, wavy boundary.

B3t-21 to 34 inches, pale-brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; weak, fine, prismatic structure; hard, very firm, sticky and plastic ; common fine roots ; common very fine tubular pores; few thin clay films on faces of peds ; few soft sandstone fragments ; neutral ; abrupt, *wavy* boundary.

C-34 inches, disintegrating sandstone ; few fine roots.

The A horizon ranges from 8 to 15 inches in thickness. It has a dry value of 5 or 6, a moist value of 3 or 4, and a chroma of 1 or 2. It is less than 18 percent clay. The B horizon ranges from 18 to 32 inches in thickness, It has a dry value of 5 or 6, a moist value of 3 or 4, a dry chroma of 3 or 4, and a moist chroma of 2 to 4. The B horizon is 18 to 34 percent clay. Depth to sandstone ranges from 26 to 40 inches.

Included with this soil in mapping were small areas of Cowviche, Burch, and Varelum soils. Also included were small areas where stones and cobblestones are on the surface and some areas of Rock outcrop.

Permeability is slow above the bedrock. Runoff is rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high. The available moisture capacity is 6 to 7 inches. This soil is subject to severe erosion if the clay subsoil is exposed during logging or road-building operations.

This soil is used mainly for woodland, range, and wildlife habitat. A small acreage is cleared and is in pasture

and orchards. Capability unit VIe-1; woodland suitability group 4r1; not in a range site; orchard group 4.

Cle Elum silt loam, 45 to 65 percent slopes (CnF).-This soil is on uplands. Included in mapping were small areas where slopes are less than 45 percent, and some areas of Rock outcrop. The areas of Rock outcrop are less than 2 percent on north-facing slopes and slightly more than 2 percent on south-facing slopes.

Runoff is very rapid, and the hazard of water erosion is very high.

This soil is used mainly for woodland, range, and wildlife habitat. Capability unit VIIe-1: woodland suitability group 4r1: not in an orchard group or a range site.

Cle Elum-Rock outcrop complex, 25 to 65 percent slopes, eroded (CoF2).-This complex is mostly on south-facing slopes on uplands. It is about 85 percent Cle Elum silt loam, 25 to 65 percent slopes, and 10 percent sandstone Rock outcrop. The remaining 5 percent is small areas of shallow and very shallow soils and some small areas where outcrops are more numerous.

Runoff is rapid to very rapid, and the hazard of erosion is high to very high.

This complex is used mainly for range and wildlife habitat. Capability unit VIIs-1; not in an orchard group, a woodland suitability group, or a range site.

Colockum Series

The Colockum series consists of well-drained, medium-textured soils that formed in glacial till of basaltic or sandstone origin mixed with some loess and volcanic ash. These soils are on uplands. Slopes are 3 to 45 percent. Where these soils are not cultivated, vegetation is mainly bluebunch wheatgrass, bluegrass. Idaho fescue, lupine, balsam root, and an occasional ponderosa pine. Elevation ranges from 1,000 to 2,500 feet. The average annual precipitation is 12 to 16 inches, average annual air temperature is 48° F., and the frost-free season is 140 to 165 days. These soils are associated mainly with Ritzville, Loneridge, and Tronsen soils.

In a representative profile the surface layer is dark grayish-brown and grayish-brown silt loam 12 inches thick. The subsoil is brown and pale-brown heavy silt loam, silty clay loam, and gravelly silty clay loam that extends to a depth of 60 inches or more.

Colockum soils are used for dryfarmed hay and wheat and for range and wildlife habitat. If these soils are irrigated, they are used mainly for the production of soft fruit.

Colockum silt loam, 8 to 15 percent slopes (CrC).-This rolling soil is on ridgetops on uplands. Slopes average 10 percent.

Representative profile, in an area 1,900 feet south and 2.000 feet west of northeast corner of sec. 29, T. 21 N., R. 21 E., Chelan County.

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

A12-6 to 12 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure ; slightly hard, friable, slightly sticky and slightly plastic ; common fine roots ; many very fine tubular pores ; mildly alkaline ; clear, smooth boundary.

B1t-12 to 26 inches, brown (10YR 5/3) heavy silt loam, dark (10YR 3/3) moist; moderate, fine and medium, prismatic structure ; hard, friable, slightly sticky and slightly plastic ; common fine roots ; many very fine tubular pores ; few thin clay films line tubular pores; mildly alkaline ; clear, smooth boundary.

B21tca-26 to 47 inches, pale-brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) moist; strong, medium, prismatic structure ; very hard, very firm, sticky and plastic ; many very fine tubular pores ; few thin clay films on ped surfaces ; few lime pockets ; mildly alkaline ; abrupt, wavy boundary.

B22tca-47 to 60 inches, pale-brown (10YR 6/3) gravelly silty clay loam, dark brown (10YR 4/3) moist; moderate, fine, subangular blocky structure; very hard, very firm, sticky and plastic ; many very fine tubular pores ; few thin clay films on ped surfaces ; strongly effervescent; moderately alkaline; 40 percent basaltic stones and gravel.

The A horizon ranges from 8 to 16 inches in thickness. It has a dry value of 4 or 5, a moist value of 2 or 3, and a dry and moist chroma of 2. Texture is silt loam or heavy silt loam. The A horizon is cobbly or bouldery in places. The B1t horizon is 12 to 20 inches thick. It has a dry value of 4 or 5, a moist value of 3 or 4, and a dry and moist chroma of 2 or 3. Texture is heavy silt loam or silty clay loam that is gravelly in places. Structure is moderate, prismatic or blocky. The B21tca horizon is 16 to 24 inches thick. It has a dry value of 4 to 6, a moist value of 3 or 4, and a dry and moist chroma of 3 or 4. Texture is silty clay loam or clay loam to silty clay that is 10 to 40 percent coarse fragments, by weighted average, consisting of gravel, cobblestones, or stones. Structure is moderate, prismatic or blocky. The B2tca horizon has thin or very thin clay films on ped faces, in pores, and bridging mineral grains. Depth to sandstone bedrock ranges from 40 inches to more than 60 inches. Depth to secondary lime ranges from 24 to 36 inches.

Included with this soil in mapping were small areas of Tronsen soils and some areas that are cobbly and bouldery.

Permeability is moderately slow. Runoff is medium ; most of it comes during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high. The available moisture capacity is 10 to 11 inches.

This soil is used for dryfarmed wheat, for range, and for orchards under irrigation. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site ; orchard group 1.

Colockum silt loam, 3 to 8 percent slopes (CrB).-This soil is on broad ridgetops on uplands. It is similar to Colockum silt loam, 8 to 15 percent slopes, except that the surface layer is 2 to 3 inches thicker.

Included with this soil in mapping were small areas where slopes are less than 3 percent or more than 8 percent.

Runoff is slow, and the hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate.

This soil is used for dryfarmed wheat, range, and orchards. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 1.

Colockum silt loam, 15 to 25 percent slopes (CrD).-This soil is on broad ridgetops on uplands. It is similar

to Colockum silt loam, 8 to 15 percent slopes, except that the surface layer is 2 inches thinner.

Included with this soil in mapping were small areas where slopes are less than 15 percent or more than 25 percent slopes.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used for dryfarmed wheat, orchards, and range. Capability unit IVe-1; not in a woodland suitability group; Loamy (L-2) or North Exposure (N-1) range site ; orchard group 2.

Colockum silt loam, 25 to 45 percent slopes (CrE).-The soil is on the sides of broad ridges on uplands. It is similar to Colockum silt loam, 8 to 15 percent slopes, except that its surface layer is 3 inches thinner. Included in mapping were small areas where slopes are less than 25 percent.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used for dryfarmed wheat, orchards, and range. Capability unit VIe-1; not in a woodland suitability group; Loamy (L-2) or North Exposure (N-1) range site; orchard group 2.

Colockum cobbly silt loam, 8 to 15 percent slopes (CsC).-This soil is in areas near the edges and tapered ends of broad ridges on uplands. It is similar to Colockum silt loam, 8 to 15 percent slopes, except that the surface layer is cobbly, and cobblestones and stones are throughout the soil. The cobblestones average 6 inches in diameter and make up about 20 percent of this soil.

Included with this soil in mapping were small areas where slopes are less than 8 percent or more than 15 percent.

Runoff is medium. and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high. The available moisture capacity is 8 to 9 inches.

This soil is used for dryfarmed wheat, orchards, and range. In cultivated areas most of the cobblestones have been removed. Capability unit IVe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 5.

Colockum cobbly silt loam, 15 to 25 percent slopes (CsD).-This soil is in areas near the edges and tapered ends of broad ridges on uplands. It is similar to Colockum silt loam, 8 to 15 percent slopes, except that the surface layer is cobbly. and cobblestones and stones are throughout the soil. The cobblestones average about 6 inches in diameter and make up 20 percent of this soil.

Included with this soil in mapping were small areas where slopes are less than 15 percent or more than 25 percent.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high. The available moisture capacity is 8 to 9 inches.

This soil is used for dryfarmed wheat, orchards, and range. Capability unit IVe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 5.

Colockum cobbly silt loam, 25 to 45 percent slopes (CsE).-This soil has south and east exposures on broad ridges on uplands. It is similar to Colockum silt loam, 8 to 15 percent slopes, except that the surface layer is cobbly, and cobblestones and stones are throughout the soil. The cobblestones average 6 inches in diameter and make up 20 percent of this soil.

Included with this soil in mapping were small areas where slopes are less than 25 percent.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high. The available moisture capacity is 8 to 9 inches.

This soil is used mainly for range. Capability unit VIe-1; not in a woodland suitability group ; Loamy (L-2) or Shallow (S-2) range site; orchard group 5.

Colockum bouldery silt loam, 25 to 45 percent slopes (CtE).-This soil is on the sides of ridges below broad ridgetops. It is similar to Colockum silt loam, 8 to 15 percent slopes, except that 0.1 percent of the surface is covered by boulders that are generally 24 to 36 inches in diameter, but some are smaller.

Included with this soil in mapping were small areas where slopes are less than 25 percent or more than 45 percent.

Runoff is rapid, and the hazard of water erosion is high. The available moisture capacity is 8 to 9 inches.

This soil is used for range and wildlife. Capability unit VIe-1; Loamy (L-2) or Shallow (S-2) range site; not in an orchard group or woodland suitability group.

Cowiche Series

The Cowiche series consists of well-drained, medium-textured soils that formed in material weathered from sandstone, gneiss, or schist and loess. These soils are on the sides and tops of ridges on uplands. Slopes are 3 to 65 percent. Where these soils are not cultivated, vegetation is mainly big sagebrush, bluebunch wheatgrass, bitterbrush, Idaho fescue, and bluegrass. Elevation ranges from 1,000 to 2,000 feet. The average annual precipitation is 9 to 15 inches, average annual air temperature is 49° F., and the frost-free season is 165 to 185 days. These soils are associated mainly with Cle Elum, Burch, Yaxon, and Bjork soils.

In a representative profile the surface layer is grayish-brown and brown silt loam 22 inches thick. The subsoil is pale-brown heavy silt loam and yellowish-brown sandy clay loam 28 inches thick. The substratum is multicolored sandy loam or loamy sand 10 inches thick. Schist bedrock underlies these soils at a depth of 60 inches.

Cowiche soils are used for orchards, vineyards, hay, pasture, range, and wildlife habitat.

Cowiche silt loam, 8 to 15 percent slopes (CwC).-This soil is on narrow ridgetops on uplands. Slopes average 12 percent.

Representative profile, in an area 1,320 feet west and 1,000 feet north of southeast corner of sec. 9, T. 23 N., R. 20 E., Chelan County

A11-0 to 8 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; Common

very fine pores ; mildly alkaline ; clear, smooth boundary.

A12--8 to 22 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; moderate, fine, prismatic structure ; slightly hard, firm, sticky and plastic ; common fine roots; many very fine pores ; mildly alkaline ; clear, smooth boundary.

B21t-22 to 36 inches, pale-brown (10YR 6/3) heavy silt loam, dark brown (10YR 4/3) moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic ; common fine roots ; many fine pores; few thin clay films occur as bridging ; mildly alkaline ; gradual, smooth boundary.

IIB22t-36 to 50 inches, light yellowish-brown (10YR 6/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; strong, moderate, subangular blocky structure ; very hard, very firm, very sticky and very plastic; few fine roots ; many very fine pores ; few thin and very thin clay films on ped surfaces; mildly alkaline ; gradual, smooth boundary.

IIC-50 to 60 inches, multicolored sandy loam or loamy sand ; massive ; loose: few fine roots: many fine pores ; moderately alkaline.

IIR-60 inches, schist bedrock.

The A1 horizon ranges from 10 to 26 inches in thickness. It has a dry value of 4 or 5, a moist value of 3. and a dry or moist chroma of 2 or 3. Structure is weak to moderate. The B2 horizon is 14 to 32 inches thick. It has a value of 5 to 7 and a chroma of 3 or 4. Texture is heavy silt loam or heavy loam. Structure is moderate or strong blocky. Content of coarse fragments in the B2t horizon ranges from 0 to 15 percent. Depth to the IIB2 horizon ranges from 20 to 38 inches. The IIB2 horizon has the same color and structure ranges as the B2 horizon, and texture is clay loam or sandy clay loam. The IIC horizon, where present, is as much as 10 inches thick. It is multicolored sandy loam or loamy sand and is single grain or massive. The IIR horizon is schist. gneiss, or sandstone bedrock. It is at a depth of more than 40 inches. Reaction is mildly alkaline to moderately alkaline throughout.

Included with this soil in mapping were small areas of Burch. Yaxon, and Bjork soils and some areas of bedrock outcrop.

Permeability is moderately slow. Runoff is medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is moderate. If this soil is irrigated. runoff is rapid and the hazard of erosion is high. The available moisture capacity is 10 to 11 inches.

This soil is used mainly for range, orchards, pasture, and wildlife habitat. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 1.

Cowiche silt loam, 3 to 8 percent slopes (CwB).-This soil is on narrow ridgetops and foot slopes on uplands. Included in mapping were small areas where slopes are less than 3 percent or more than 8 percent.

Runoff is slow, and the hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate.

This soil is used mainly for range, orchards, pasture, and wildlife habitat. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 1.

Cowiche silt loam, 15 to 25 percent slopes (CwD).-This soil is in areas near the edges of ridges and on foot slopes on uplands. It is similar to Cowiche silt loam, 8 to 15 percent slopes, except that the depth to bedrock generally is shallower.

Included with this soil in mapping were small areas where slopes are less than 15 percent or more than 25 percent and some areas of shallower soils.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mainly for orchards, pasture, wildlife habitat, and range. Capability unit IVe-1; not in a woodland suitability group: Loamy (L-2) or Shallow (S-2) range site; orchard group 2.

Cowiche silt loam, 25 to 45 percent slopes (CwE).-This soil is on side slopes on uplands. It is similar to Cowiche silt loam, 8 to 15 percent slopes, except that it is slightly shallower to bedrock.

Included with this soil in mapping were small areas where slopes are less than 25 percent or more than 45 percent.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the erosion hazard is very high.

This soil is used mostly for range and wildlife habitat. Capability unit VIe-1; not in a woodland suitability group; Shallow (S-2) or North Exposure (N-1) range site; orchard group 2.

Cowiche silt loam, 45 to 65 percent slopes (CwF).-This soil is on side slopes on uplands. It is similar to Cowiche silt loam. 8 to 15 percent slopes, except that it is slightly shallower to bedrock.

Included with this soil in mapping were small areas where slopes are less than 45 percent and some areas that are rocky.

Runoff is very rapid, and the hazard of water erosion is very high.

This soil is used mostly for range and wildlife habitat. Capability unit VIIe-1; Shallow (S-2) or North Exposure (N-1) range site; not in an orchard group or a woodland suitability group.

Dinkelman Series

The Dinkelman series consists of well-drained, moderately coarse textured soils that formed in material weathered from granite and granodiorite. They also contain some loess, volcanic ash, and pumice. These soils are in the mountainous uplands. Slopes are 0 to 60 percent. Native vegetation is Douglas-fir, ponderosa pine, bitterbrush, bluegrass, pinegrass, sedge, and bluebunch wheatgrassf Elevation ranges from 1,800 to 3,500 feet. The average annual precipitation is 12 to 24 inches, average annual air temperature is about 46° F., and the frost-free season is 120 to 150 days. These soils are associated mainly with Tyee, Thow, and Entiat soils.

In a representative profile the surface layer is grayish-brown gravelly sandy loam 15 inches thick. The subsoil is light yellowish-brown gravelly sandy loam 27 inches thick. Granodiorite bedrock underlies these soils at a depth of 42 inches.

Dinkelman soils are used mostly for woodland and wildlife habitat.

Dinkelman gravelly sandy loam, 30 to 60 percent slopes (DmF).-This soil is on the sides of mountains. Slopes average 50 percent.

Representative profile, at the first spur road to left

across abandoned farm yard, 1.6 miles up Oklahoma Gulch from Navarre Coulee in NE1/4SW1/4 sec. 8, T. 26 N., R. 21 E., Chelan County:

O2-2 inches to 0, partly decomposed needles, twigs, cones, and dry grass.

A1-0 to 3 inches, grayish-brown (10YR 5/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; massive ; soft, friable, slightly sticky and nonplastic ; common medium and coarse roots; many fine, medium, and coarse tubular pores ; slightly acid ; gradual, wavy boundary.

A3-3 to 15 inches, grayish-brown (10YR 5/2) gravelly sandy loam, dark brown (10YR 3/3) moist; weak, fine, granular structure ; soft, friable, slightly sticky and nonplastic ; common fine, medium, and coarse roots ; many fine, medium, and coarse tubular pores ; 30 percent gravel ; slightly acid ; gradual, wavy boundary.

B2-15 to 42 inches, light yellowish-brown (10YR 6/4) gravelly sandy loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and nonplastic ; few medium and coarse roots ; many fine, medium, and coarse tubular pores ; 25 percent gravel ; neutral ; clear, wavy boundary.

R-42 inches, fractured decomposed weathered granodiorite.

The A1 horizon ranges from 3 to 10 inches in thickness. It has a dry value of 4 or 5, a moist value of 3, and a dry and moist chronic of 1 or 2. Structure is weak, or the horizon is massive. The A3 horizon is 11 to 16 inches thick. The B2 horizon is 26 to 34 inches thick. It has a value of 5 or 6 and a chroma of 3 or 4. Texture is gravelly sandy loam or gravelly loam. The B horizon has weak structure, or the horizon is massive. Depth to weathered granite bedrock ranges from 40 to 60 inches. Content of coarse fragments in the profile ranges from 15 to 35 percent, by volume. Reaction is neutral or slightly acid throughout.

Included with this soil in mapping were small areas of Tyee, Entiat, and Thow soils and some areas that are rocky.

Permeability is moderately rapid. Runoff is rapid to very rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is high to very high. The available moisture capacity is 5 to 6 inches.

This soil is used mainly for wildlife habitat. Capability unit VIe-1; woodland suitability group 5r2 ; not in an orchard group or a range site.

Dinkelman gravelly sandy loam, 0 to 30 percent slopes (DmD).-This soil is on the sides of mountains on uplands. Included in mapping were small areas where slopes are more than 30 percent and some areas of bedrock outcrop. Runoff is medium, and the hazard of water erosion is moderate.

This soil is used for woodland and wildlife habitat. Capability unit IVe-1; woodland suitability group 5o2; not in an orchard group or a range site.

Dinkelman-Rock outcrop complex, 0 to 60 percent slopes (DrF).-This complex is on the sides of mountains on uplands. It consists of about 90 percent Dinkelman soils and about 10 percent Rock outcrop.

Included with this complex in mapping were small areas that have fewer rock outcrops than these soils and areas of shallow and very shallow soils.

Runoff is slow to very rapid, and the hazard of water erosion is slight to very high.

This complex is used for woodland and wildlife habitat. Capability unit VIIs-1; woodland suitability group 5x1; not in an orchard group or a range site.

Ellisforde Series

The Ellisforde series consists of well-drained, medium-textured and moderately coarse textured soils that formed in reworked lacustrine sediment that has windlaid silt and fine sandy loam deposited on the surface. These soils are on lake terraces. Slopes are 3 to 15 percent. Where these soils are not cultivated, vegetation is mainly bluebunch wheatgrass, bluegrass, sagebrush, and rabbitbrush. Elevation ranges from 800 to 1,300 feet. The average annual precipitation is 8 to 12 inches, average annual air temperature is about 52° F., and the frost-free season is 160 to 180 days. These soils are associated mainly with Burch, Ritzville, and Pogue soils.

In a representative profile the surface laser is brown silt loam 16 inches thick. The subsoil is grayish-brown silt loam 12 inches thick. The substratum is calcareous light brownish-gray silt loam and very fine sandy loam to a depth of 60 inches or more.

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

Ellisforde silt loam, 8 to 15 percent slopes (ElC).-This soil is on lake terraces. Slopes average 10 percent.

Representative profile, in an area on east side of road, 90 feet north of driveway to white house, NE1/4NW1/4 sec. 32, T. 22 N., R. 21 E., Chelan County:

A11-0 to 6 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, medium, platy structure; soft, very friable, slightly sticky and slightly plastic ; common fine roots ; few fine tubular pores ; moderately alkaline ; abrupt, smooth boundary.

A12-6 to 16 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure; soft, very friable, slightly sticky and slightly plastic ; common fine roots ; few fine tubular pores ; moderately alkaline; clear, smooth boundary.

B2-16 to 28 inches, grayish-brown (2.5Y 5/2) silt loam, very dark grayish brown (2.5Y 3/2) moist; moderate, coarse, prismatic structure ; hard, friable, slightly sticky and slightly plastic ; common fine roots; few fine tubular pores ; moderately alkaline ; abrupt, wavy boundary.

IIC1ca-28 to 47 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; moderate, coarse, prismatic structure ; slightly hard, very friable, slightly sticky and slightly plastic ; few fine roots ; few medium tubular pores ; moderately alkaline ; strongly effervescent ; abrupt, wavy boundary.

IIC2ca-47 to 60 inches, light brownish-gray (2.5Y 6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) moist ; massive ; soft, very friable, slightly sticky and slightly plastic ; few fine roots ; few medium tubular pores ; strongly alkaline ; strongly effervescent.

The A horizon ranges from 12 to 20 inches in thickness. It has a chroma of 2 or 3. Its structure, in places, is weak, medium, platy or weak, medium, granular. The B horizon is 10 to 14 inches thick. It has a hue of 10YR or 2.5Y, a value of 5 or 6, and a chroma of 2 or 3. Structure, in places, is moderate, coarse, prismatic or moderate, medium, subangular blocky. The IIC horizon is noncalcareous in places. It ranges from 2.5Y to 10YR in hue. The IIC1ca horizon ranges from 16 to 20 inches in thickness.

Included with this soil in mapping were small areas of Burch soils and areas that have a surface layer of fine sandy loam.

Permeability is moderately slow. Runoff is medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is moderate. If this soil is irri-

gated, runoff is rapid and the hazard of erosion is high. The available moisture capacity is 10 to 12 inches.

This soil is used mostly for orchards and hay. Capability unit IIIe-1; not in a woodland suitability group ; Loamy (L-2) range site; orchard group 1.

Ellisforde fine sandy loam, 3 to 8 percent slopes (EfB).-This soil is on lake terraces. It is similar to Ellisforde silt loam, 8 to 15 percent slopes, except that it has a surface layer of fine sandy loam.

Included with this soil in mapping were small areas where slopes are less than 3 percent or more than 8 percent and areas where the surface layer is silt loam.

Runoff is slow, and the hazard of water erosion is slight. If this soil is irrigated; runoff is medium and the hazard of erosion is moderate. The available moisture capacity is 9 to 11 inches. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 1.

Entiat Series

The Entiat series consists of well-drained, moderately coarse textured soils that formed in decomposing granodiorite, granite, or gneiss bedrock. Varying amounts of loess, volcanic ash. and pumice are in the surface layer. These soils are on uplands. Slopes are 0 to 65 percent. Native vegetation is mainly bluebunch wheatgrass, balsamroot, bluegrass, lupine, bitterbrush, and, in places, scattered ponderosa pine and Douglas-fir. Elevation ranges from 1,000 to 2,500 feet. The average annual precipitation is 9 to 14 inches, average annual air temperature is 50° to 60° F.. and the frost-free season is 150 to 165 days. These soils are associated mainly with Tyee, Dinkelman, and Cashmont soils.

In a representative profile the surface layer is grayish-brown sandy loam 3 inches thick. Below this layer is brown gravelly sandy loam 5 inches thick. The substratum is brown very gravelly sandy loam 10 inches thick. Acid, igneous bedrock underlies these soils at a depth of 18 inches.

Entiat soils are used for range and wildlife habitat.

Entiat sandy loam, 0 to 25 percent slopes (EnD).-This soil is on the sides and tops of ridges on uplands. Average slope is 15 percent.

Representative profile, in an area 440 feet south and 1,000 feet west of east quarter corner of sec. 9, T. 26 N., R. 21 E., Chelan County:

A1-0 to 3 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; few fine tubular pores ; mildly alkaline ; clear, smooth boundary.

AC-3 to 8 inches, brown (10YR 5/3) gravelly sandy loam, dark brown (10YR 3/3) moist; weak, fine, prismatic structure ; soft, very friable, nonsticky and nonplastic ; approximately 45 percent gravel ; common fine roots ; few fine tubular pores ; mildly alkaline; clear, smooth boundary.

C1-8 to 18 inches, brown (10YR 5/3) very gravelly sandy loam, dark brown (10YR 3/3) moist; massive; soft. very friable, nonsticky and nonplastic ; approximately 60 percent gravel ; few fine roots ; few fine tubular pores ; mildly alkaline ; clear, wavy boundary.

C2-18 inches, decomposing granodiorite.

The A horizon ranges from 2 to 4 inches thickness. It has a dry value of 4 or 5, a moist value of 2 or 3, and a moist and dry chroma of 2 or 3. Structure ranges from weak, fine, subangular blocky to weak, thin, platy or weak, fine, granular. The content of gravel ranges from 5 to 15 percent. The AC horizon is 4 to 6 inches thick. It has a hue of 10YR, a dry value of 4 or 5, a moist value of 3, and a dry and moist chroma of 2 or 3. Texture ranges from loam to sandy loam, and structure ranges from weak, medium, prismatic to weak, medium, granular to weak, medium, subangular blocky. The content of gravel ranges from 30 to 50 percent. The C1 horizon is 8 to 10 inches thick. It has a dry value of 4 to 6 and a dry chroma of 3 or 4. Moist value and chroma are 3 or 4. The content of gravel ranges from 50 to 60 percent. A few cobblestones and a small amount of pumice and ash are in the profile.

Included with this soil in mapping were small areas of Tyee and Dinkelman soils and some areas of soils that have a loam surface layer.

Permeability is moderately rapid. Runoff is slow to medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is slight to moderate. If this soil is irrigated, runoff is slow to very' rapid and the hazard of erosion is slight to very high. The available moisture capacity is about 3 inches.

This soil is used mainly for range and wildlife habitat. Capability unit VIe-1: not in a woodland suitability group; Shallow (S-2) range site: orchard group 4.

Entiat sandy loam, 25 to 65 percent slopes (EnF).-This soil is on side slopes on uplands. It is similar to Entiat sandy loam, 0 to 25 percent slopes, except that it is slightly shallower.

Included with this soil in mapping were small areas where slopes are less than 25 percent. Also included in places were areas that are 2 to 10 percent Rock outcrop.

Runoff is rapid to very rapid, and the hazard of water erosion is high to very high.

This soil is used mainly for range and wildlife habitat. Capability unit VIIe-1: Shallow (S-2) range site; not in an orchard group or a woodland suitability group.

Entiat-Rock outcrop complex, 25 to 65 percent slopes (ErF).-This complex is on side slopes on uplands. It consists of about 90 percent Entiat sandy loam, 25 to 65 percent slopes, and of about 10 percent Rock Outcrop.

Included with this complex in mapping were small areas where slopes are less than 25 percent, some areas that have no Rock outcrop, areas of a very shallow soil, and areas that are as much as 10 percent talus slopes. Also included in places were small areas of deep, loose, gravelly soils.

Runoff is rapid to very rapid, and the hazard of water erosion is high to very high.

This complex is used mainly for range and wildlife habitat. Capability unit VIIe-1; Shallow (S-2) range site; not in an orchard group or a woodland suitability group.

Goddard Series

The Goddard series consists of well drained, moderately coarse textured soils that formed in volcanic ash, pumice, and some loess over gravelly glacial outwash. These soils are on terraces in the Lake Wenatchee area. Slopes are 0 to

8 percent. Native vegetation is mainly ponderosa pine, Douglas-fir, pinegrass, spirea, and ocean-spray. Elevation ranges from 1,700 to 2,500 feet. The average annual precipitation is 25 to 40 inches, average annual air temperature is about 45° F., and the frost-free season is 80 to 125 days. These soils are associated mainly with Chiwawa, Nevine, and Nard soils.

In a representative profile the surface layer is grayish-brown fine sandy loam 3 inches thick. The subsoil is pale-brown fine sandy loam and very pale brown sandy loam 21 inches thick. Glacial outwash sand, gravel, and cobblestones underlie these soils at a depth of 24 inches.

Goddard soils are used mainly for woodland, wildlife habitat, and summer homesites. A small acreage is cleared and used for hay and pasture.

Goddard fine sandy loam, 0 to 3 percent slopes (GoA).-This soil is on terraces. Slopes average 2 percent.

Representative profile, in an area 1,800 feet east of west quarter corner of sec. 12, T. 26 N., R. 17 E., Chelan County:

A1-0 to 3 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, crumb structure; soft, very friable, nonsticky and nonplastic ; common fine roots ; few fine tubular pores ; 8 percent gravel and pumice ; neutral ; abrupt, wavy boundary.

B21ir-3 to 7 inches, pale-brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3) moist; weak, medium, prismatic structure ; soft, very friable, nonsticky and nonplastic ; few fine roots ; few fine tubular pores ; 8 percent gravel and pumice; neutral; gradual, wavy boundary.

B22ir-7 to 24 inches, very pale brown (10YR 7/3) sandy loam, dark yellowish brown (10YR 4/4) moist; weak, medium, prismatic structure ; soft, very friable, nonsticky and nonplastic ; few fine roots; few fine tubular pores ; 7 percent gravel and pumice ; neutral ; abrupt, wavy boundary.

IIC-24 to 60 inches, sand, gravel, and cobblestones.

The Al horizon ranges from 2 to 4 inches in thickness. The A2 horizon, where present, has a dry value of 5 or 6, a moist value of 3 or 4, and a moist and dry chroma of 1. The B horizon is 18 to 28 inches thick. It has a dry value of 5 to 7, a moist value of 3 or 4, and a moist and dry chroma of 3 or 4. The IIC horizon is gravelly. cobbly, or stony. The upper part of this soil is more than 60 percent pyroclastic material. Content of coarse fragments in the upper part ranges from 5 to 15 percent and in the lower part from 50 to 75 percent.

Permeability is moderate to a depth of 24 inches and very rapid below. Runoff is slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is slight. The available moisture capacity is 4 to 6 inches.

This soil is used mainly for woodland and wildlife habitat. Capability unit IVe-1; woodland suitability group 5o3; not in an orchard group or a range site.

Goddard cobbly fine sandy loam, 0 to 8 percent slopes (GsB).-This soil is on terraces that border the Wenatchee River in the Lake Wenatchee area. It is similar to Goddard fine sandy loam, 0 to 3 percent slopes, except that the soil is cobbly throughout.

Included with this soil in mapping were small areas of Chiwawa soils and some areas of Goddard soils that have a noncobbly surface layer.

Runoff is very slow to slow, and the hazard of water erosion is none to slight. The available moisture capacity is 3 to 5 inches.

This soil is used mainly for woodland and wildlife habitat. Capability unit IVe-1; woodland suitability group 5o3; not in an orchard group or a range site.

Jumpe Series

The Jumpe series consists of well-drained, medium-textured soils that formed in volcanic ash and glacial till from basalt. These soils are on mountainous uplands. Slopes are 0 to 65 percent. Vegetation is mainly Douglas-fir, larch, lodgepole pine, and spruce and an understory of pinegrass and brush. Elevation ranges from 4,500 to 5,500 feet. The average annual precipitation is 30 to 35 inches, average annual air temperature is 44° F., and the frost-free season is 100 to 115 days. These soils are associated mainly with Loneridge soils.

In a representative profile the surface layer is grayish-brown fine sandy loam 1 inch thick. The subsoil is a grayish-brown stony silt loam and light yellowish-brown very stony silt loam 29 inches thick. The substratum is light yellowish-brown very stony silt loam that extends to a depth of 60 inches or more.

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

Jumpe stony silt loam, 0 to 25 percent slopes (JmD).-This soil is on mountainous uplands. Slopes average 8 percent.

Representative profile, in an area 400 feet south and 1,500 feet east of northwest corner of sec. 14, T. 20 N., R. 20 E., Kittitas County:

O1-2 inches to 0, partly decomposed duff.

A2-0 to 1 inch, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure ; soft, very friable, nonsticky and nonplastic ; many fine and medium roots ; few stones ; very strongly acid ; abrupt, wavy boundary.

B21ir-1 to 10 inches, grayish-brown (10YR 5/4) stony silt loam, dark yellowish brown (10YR 3/4) moist; weak, medium, crumb structure parting to weak, fine, crumb structure ; soft, friable, slightly sticky and nonplastic ; many fine and medium roots ; few fine tubular pores ; approximately 15 percent stones, gravel, and cobblestones ; very strongly acid ; abrupt, smooth boundary.

B22ir-10 to 30 inches, light yellowish-brown (10YR 6/4) very stony silt loam, dark yellowish brown (10YR 4/4) moist, massive ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; many fine tubular pores ; approximately 60 percent stones, gravel, and cobblestones ; strongly acid ; abrupt, smooth boundary.

C to 60 inches, light yellowish-brown (10YR 6/4) very stony silt loam, dark yellowish brown (10YR 4/4) moist; massive ; slightly hard, friable, slightly sticky and slightly plastic ; common fine roots ; fine tubular pores ; approximately 70 percent stones, gravel, and cobblestones ; strongly acid.

In some places an A1 horizon is less than 1 inch thick and is very dark grayish brown (10YR 3/2) when moist. The A2 horizon has a dry value of 5 or 6, a moist value of 4 or 5, and a dry and moist chroma of 1 or 2. Structure is granular or crumb. The B2ir horizon is 20 to 36 inches thick. It has a hue of 10YR or 7.5YR, a dry value of 5 or 6, a moist value of 3 or 4, and a dry and moist chroma of 3 or 4. Texture is silt loam or loam that is 35 to 60 percent stones, cobblestones, or gravel, by weighted average. This horizon has weak structure or is massive. The C horizon has a dry value of 5 or 6, a moist

value of 4, and a dry and moist chroma of 3 or 4. Texture is silt loam or loam that is 50 to 75 percent stones. cobblestones, or gravel, by weighted average. Reaction is strongly acid to very strongly acid throughout. The soil is 50 to 75 percent coarse fragments, by weighted average, and texture is silt loam or loam.

Included with this soil in mapping were small areas where the surface is very stony. Also included were some small areas of Loneridge soils and other Jumpe soils.

Permeability is moderate. Runoff is slow to medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is slight to moderate. The available moisture capacity is about 60 inches. Roots penetrate to the full depth of the soil.

This soil is used mainly for woodland and wildlife habitat. Capability unit VIe-1; woodland suitability group 5o1; not in an orchard group or a range site.

Jumpe very stony silt loam, 25 to 65 percent slopes (JnF).-This soil is on mountainous uplands. Included in mapping were small areas that have fewer stones than this soil and some areas where slopes are less than 25 percent.

Runoff is rapid to very rapid, and the hazard of water erosion is high to very high. The available moisture ca pacity is about 5 inches.

This soil is used mainly for woodland and wildlife habitat. Capability unit VIIs-1: woodland suitability group 5x1; Shallow (S-3) range site; not in an orchard group.

Jumpe Series, Red Variant

The Jumpe series, red variant, consists of well-drained, medium-textured soils that formed in volcanic ash and glacial till from basalt. These soils are on mountainous uplands. Slopes are 15 to 45 percent. Vegetation is mainly Douglas-fir, white fir, lodgepole pine, scattered larch, lupine, and pinegrass. Elevation ranges from 3,000 to 4,700 feet. The average annual precipitation is 22 to 30 inches, average annual air temperature is about 43° F., and the frost-free season is 100 to 120 days. These soils are associated mainly with Loneridge and other Jumpe soils.

In a representative profile the surface layer is pinkish-gray very fine sandy loam one-half inch thick. The subsoil is brown loam' about 101' inches thick. The substratum is light grayish-brown, cobbly very fine sandy loam and cobbly silt loam that extends to a depth of 60 inches or more.

These soils are used for woodland and wildlife habitat.

Jumpe stony loam, red variant, 15 to 45 percent slopes (JuE).-This soil is on side slopes and broad tops of ridges between drainageways on mountainous uplands.

Representative profile, in an area. 1,000 feet south and 2,700 feet west of the northeast corner of sec. 11, T. 20 N., R. 20 E., Kittitas County:

O1&O2-4 inches to 0, decomposed and partly decomposed duff.

A2-0 to 1/2 inch, pinkish-gray (7.5YR 6/2) stony fine sandy loam, dark brown (7.5YR 3/2) moist ; single grain ; soft, very friable, nonsticky and nonplastic; many fine and medium roots ; neutral ; abrupt, wavy boundary.

B2ir-1/2 to 11 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; weak, fine, granular structure ; soft, very friable, nonsticky and nonplastic ; many fine and medium roots; many fine tubular pores; approximately 20 percent stones, cobblestones, and gravel ; slightly acid; abrupt, wavy boundary.

IIC1-11 to 33 inches, light grayish-brown (7.5YR 6/2) cobbly very fine sandy loam, dark brown (7.5YR 4/2) moist ; weak, fine, subangular blocky structure ; soft, very friable. nonsticky and nonplastic ; many fine roots ; many fine tubular pores; approximately 30 percent stones; cobblestones, and gravel; neutral; abrupt, wavy boundary.

IIC2-33 to 60 inches, light grayish-brown (7.5YR 6/2) cobbly silt loam, dark brown (7.5YR 4/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic ; common fine roots ; few fine tubular pores ; approximately 40 percent stones, cobblestones, and gravel; neutral.

The solum ranges from 10 to 15 inches in thickness. Stone cover on this soil ranges from 0.01 to 3.0 percent. The A2 horizon is nearly continuous in undisturbed areas, but it is missing in some disturbed areas. The B2ir horizon is 10 to 14 inches thick. It has a dry value of 5 or 6, a moist value of 3 or 4, a dry and moist chroma of 2 to 4, and a dry and moist hue of 7.5YR or 5YR. Texture is mainly fine sandy loam, loam, or very fine sandy loam that is gravelly, stony, or cobbly in places. This horizon has weak, granular or blocky structure. The IIC1 horizon is 18 to 26 inches thick. It has a dry value of 5 or 6, a moist value of 4. a dry or moist chroma of 2, and a hue of 7.5YR or 10YR. Texture is very fine sandy loam or silt loam that is stony or cobbly.

Included with this soil in mapping were small areas where the surface is very stony. Also included were small areas where slopes are less than 15 percent or more than 45 percent.

Permeability is moderate. Runoff is medium to rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is moderate to high. The available moisture capacity is about 8 inches.

This soil is used mainly for woodland and wildlife habitat. Capability unit VIIs-1; woodland suitability group 5x1; not in an orchard group or a range site.

Jumpe Series, Thick Surface Variant

The Jumpe series, thick surface variant, consists of well-drained, medium-textured soils that formed in volcanic ash and glacial till of basaltic origin. These soils are on mountainous uplands. Slopes are 8 to 25 percent. Vegetation is slender hairgrass, mountain brome, Columbia needlegrass, sedge, and scattered ponderosa pine. Elevation ranges from 4,500 to 5,550 feet. The average annual precipitation is 25 to 30 inches, average annual air temperature is about 44° F., and the frost-free season is 100 to 120 days. These soils are associated mainly with Loneridge and other Jumpe soils.

In a representative profile the surface layer is dark reddish-gray silt loam and reddish-gray and brown cobbly silt loam and silt loam 10 to 24 inches thick. The subsoil is brown cobbly silt loam 36 inches thick or more.

Jumpe soils, thick surface variant, are used for range and wildlife habitat.

Jumpe stony silt loam, thick surface variant, 8 to 25 percent slopes (JvD).-This soil is on the broad tops of ridges on mountainous uplands.

Representative profile, in an area 300 feet east and 1,320 feet north of southwest corner of sec. 14, T. 20 N., R. 20 E., Kittitas County:

A11-0 to 6 inches, dark reddish-gray (5YR 4/2) silt loam, dark reddish brown (5YR 2/2) moist ; moderate, fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic : many fine roots ; few fine tubular pores ; approximately 15 percent stones ; very strongly acid ; abrupt, smooth boundary.

A12-6 to 12 inches, reddish-gray (5YR 5/2) cobbly silt loam, dark reddish brown (5YR 3/2) moist; weak, coarse, prismatic structure parting to weak, medium, crumb structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; many fine tubular pores ; approximately 20 percent stones and cobblestones : strongly acid ; abrupt, smooth boundary.

A13-12 to 24 inches, brown (7.5YR 5/2) cobbly silt loam, dark brown (7.5YR 3/2) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic ; common fine roots ; many fine tubular pores; approximately 30 percent stones and cobblestones ; strongly acid ; abrupt, wavy boundary.

IIB2-24 to 60 inches, brown (7.5YR 5/4) cobbly heavy silt loam, dark brown (7.5YR 4/2) moist;' moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic ; common fine roots ; many fine tubular pores; approximately 45 percent stones and cobblestones; thin patchy clay films in pores ; strongly acid.

The A horizon ranges from 20 to 44 inches in thickness. It has a dry value of 4 or 5, a moist value of 2 or 3, a dry and moist chroma of 2 or 3. and a hue of 5YR or 7.5 YR. Texture is mainly loam or silt loam that is gravelly, cobbly, or stony, and in places, it consists of 10 to 30 percent coarse fragments. Structure is moderate or weak. The IIB2 horizon has a dry value of 5 or 6, a moist value of 3 or 4, a dry and moist chroma of 2 to 4, and a hue of 10YR or 7.5YR. Texture in this horizon is loam, silt loam, silty clay loam, or clay loam that is 20 to 30 percent clay, and the horizon is gravelly, cobbly, or stony and is 35 to 50 percent coarse fragments. Structure is moderate to weak, blocky. Reaction is very strongly acid or strongly acid throughout.

Included with this soil in mapping were small areas that have almost no stones. Also included were small areas of Loneridge and other Jumpe soils.

Permeability is moderate. Runoff is medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is moderate. The available moisture capacity is about 8 inches.

This soil is used for range and wildlife habitat. Capability Unit VIe-1; woodland suitability group 5o1; Mountain Park range site; not in an orchard group.

Leavenworth Series

The Leavenworth series consists of moderately well drained, moderately coarse textured and coarse textured soils that formed in recent alluvium from granite. gneiss, schist, and micaceous sandstone rocks. These soils are on bottom lands and low terraces adjacent of streams. Slopes are 0 to 3 percent. Where these soils are not cultivated, vegetation is mainly ponderosa pine, Douglas-fir, pinegrass, snowberry, rose, and ninebark. Elevation ranges from 1,100 to 1,500 feet. The average annual precipitation is 15 to 25 inches, average annual air temperature is 46° to 50° F. and the frost-free season is 130 to 165 days. These soils are associated mainly with Brief and Peshastin soils and Alluvial Land.

In a representative profile the surface layer is dark-gray fine sandy loam that is gravely- in places. It is 23 inches thick. This is underlain by dark-gray, stratified layers of loamy fine sandy and loam that extend to a depth of 60 inches or more.

Leavenworth soils are used mainly for irrigated pasture. A small acreage is in orchards.

Leavenworth fine sandy loam (Lh).-This soil is on low terraces and bottom lands adjacent to streams. Slopes average 1 percent.

Representative profile, in an area 900 feet east of the northwest corner of sec. 24, T. 24 N., R. 17 E., Chelan County.

Ap-0 to 7 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, coarse, granular structure ; soft, friable, nonsticky and nonplastic ; many fine roots; few fine tubular pores ; mildly alkaline; abrupt, smooth boundary.

A12-7 to 23 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, coarse, prismatic structure ; soft, friable, nonsticky and nonplastic common fine roots ; many very fine tubular pores mildly alkaline ; clear, smooth boundary.

C-23 to 60 inches, dark-gray (10YR 4/1), stratified layers of micaceous loamy fine sand and loam, very dark brown (10YR 2/2) moist; massive; soft, friable, slightly sticky and nonplastic ; few fine roots ; few very fine tubular pores: mildly alkaline.

The Ap and A12 horizons have a combined thickness of 21 to 25 inches. They have a hue of 10YR or 2.5Y, a dry value of 4 or 5, a moist value of 2 or 3. and a moist and dry chroma of 1 or 2. Structure is weak to moderate, granular or prismatic. The C horizon has a hue of 10YR to 5Y, a dry value of 4 or 5, a moist value of 2 or 3, and a moist and dry chroma of 1 or 2. In some places reddish mottles are at a depth below 40 inches. Texture of the C horizon is mainly loam or fine sandy loam that has thin lenses of loamy fine sand less than 1 inch thick in places. Thin subhorizons contain as much as 30 percent coarse fragments in places. Reaction is neutral to mildly alkaline throughout.

Included with this soil in mapping were small areas of Brief soils and some areas where the surface layer is loamy sand and loam.

Permeability is moderate. Runoff is very slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight. These soils are subject to occasional stream overflow in some places. The available moisture capacity is about 7 to 8 inches.

This soil is used mainly for irrigated pasture. A small acreage is in orchards. Capability unit IIIe-1; woodland suitability group 2o1; not in a range site; orchard group 1.

Leavenworth loamy sand (Le).-This soil is on low terraces and bottom lands adjacent to streams. Included in mapping were small areas where the surface layer is fine sandy loam or gravelly fine sandy loam.

Permeability is moderately rapid. Runoff is very slow, and the hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight. The available moisture capacity is 5 to 7 inches. In places this soil is subject to occasional stream overflow during periods of high water.

This soil is used mainly for irrigated pasture. Capability unit IVe-1; woodland suitability group 2o1; not in a range site; orchard group 1.

Loneridge Series

The Loneridge series consists of well-drained, medium-textured soils that formed in glacial till primarily of basalt origin, but some loess and volcanic ash are mixed in the surface laver. These soils are on mountainous uplands. Slopes are 0 to 65 percent. Native vegetation is primarily ponderosa pine and scattered Douglas-fir and larch. The understory is pinegrass, sedge, bluebunch wheatgrass, fiscues, and many forb and shrub species. Elevation ranges from 2,700 to 5,500 feet. The average annual precipitation is 16 to 30 inches, average annual air temperature is about 45° F., and the frost-free season is 75 to 100 days. These soils are associated with Colockum, Jumpe, Stemilt, and Tronsen soils.

In a representative profile the surface layer is grayish-brown very stony loam 10 inches thick. The subsoil is yellowish-brown very gravelly clay loam and brown very gravelly clay that extends to a depth of 60 inches or more.

Loneridge soils are used for woodland, range, and wildlife habitat.

Loneridge very stony loam, 0 to 25 percent slopes (LoD).-This soil is on ridges and terraces on mountainous uplands. Slopes average 8 to 15 percent.

Representative profile, in an area 500 feet south and 500 feet east of west quarter, corner sec. 5, T. 20 N., R. 21 E., Kittitas County:

O1&O2-1 inch to 0, loose, partly decomposed and decomposed organic litter, consisting of needles, twigs, leaves, and cones.

A1-0 to 10 inches, grayish-brown (10YR 5/2) very stony loam, dark grayish brown (10YR 3/2) moist; weak, fine and medium, subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic ; common fine and medium roots ; common very fine tubular pores ; 0.1 to 3 percent stones on surface and about 20 percent gravel in horizon ; mildly alkaline ; clear, wavy boundary.

B1t-10 to 16 inches, yellowish-brown (10YR 5/4) very gravelly clay loam, dark yellowish brown (10YR 3/4) moist ; moderate, fine, subangular blocky structure ; hard, firm, sticky and plastic ; few fine roots ; many very fine tubular pores ; approximately 60 percent gravel, cobblestones, and stones ; many thin clay films on ped surfaces ; mildly alkaline ; gradual, wavy boundary.

B2t-16 to 60 inches, brown (7.5YR 5/4) very gravelly clay, dark brown (7.5YR 4/4) moist; strong, fine, subangular blocky structure; very hard, very firm, sticky and plastic ; few fine roots ; many very fine tubular pores ; approximately 75 percent gravel, cobblestones, and stones ; many thin clay films on ped surfaces ; mildly alkaline.

The A horizon ranges from 10 to 12 inches in thickness. It has a hue of 10YR to 7.5YR. Moist value and chroma are 2 or 3, dry value is 4 or 5, and dry chroma is 2. Content of stones and gravel in this horizon ranges from 15 to 75 percent. The soil has a stone cover of 0.01 to 3.0 percent. The structure is weak or moderate blocky. The B1t horizon is 4 to 8 inches thick. The B2t horizon is dominantly 7.5YR in hue but ranges from 10YR to 5YR, depending on the parent material. It has a moist value and chroma of 2 to 4, a dry value of 3 to 6, and a dry chrome, of 3 or 4. The B2t horizon is clay loam, clay, or silty clay. The percent of stones, cobblestones, and gravel ranges from 35 to 85 percent, but the weighted average is 50 to 75 percent. Structure is moderate or strong, blocky or prismatic, The soil is clay loam. clay, or silty clay that contains 50 to 75 percent coarse fragments, by weighted average.

Reaction is neutral to mildly alkaline throughout.

Included with this soil in mapping were small areas of Stemilt, Loneridge, and Anatone soils and some areas where the surface is less stony than that of this soil.

Permeability is moderately slow. Runoff is slow to medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is slight to moderate. The avail able moisture capacity is about 4 to 5 inches.

This soil is used mostly for woodland, wildlife habitat, and range. Capability unit VIIs-1; woodland suitability group 5x1; not in an orchard group or a range site.

Loneridge very stony loam, 25 to 65 percent slopes (LoF).-This soil is on mountainous uplands and terraces. It is similar to Loneridge very stony loam, 0 to 25 percent slopes, except that it has slightly more rock outcrop and the surface layer is thinner.

Included with this soil in mapping were small areas where slopes are less than 25 percent and some areas where the surface is less stony than that of this soil.

Runoff is rapid to very rapid, and the hazard of water erosion is high to very high.

This soil is used mainly for woodland, wildlife habitat, and range. Capability unit VIIs-1; woodland suitability group 5x1; not in an orchard group or a range site.

Loneridge stony loam, 0 to 25 percent slopes (LnD).-This soil is on broad ridgetops on mountainous uplands. It is similar to Loneridge very stony loam, 0 to 25 percent slopes, except that the surface layer is slightly darker and deeper. Depth to bedrock ranges from 40 to 60 inches.

Included with this soil in mapping were small areas of Jumpe and Anatone soils and areas where the surface is very stony.

Runoff is slow to medium, and the hazard of water erosion is slight to moderate. The avail able moisture capacity is 5 to 6 inches.

This soil is used mainly for woodland, wildlife habitat, and range. Capability unit VIe-1; woodland suitability group 4x1; not in an orchard group or a range site.

Malaga Series

The Malaga series consists of somewhat excessively drained, moderately coarse textured soils that formed in glacial outwash derived mainly from acid igneous gravel and cobblestones. These soils are on terraces near the Columbia River south of Wenatchee. Slopes are 0 to 15 percent. Where these soils are not cultivated, vegetation is mainly rabbitbrush, bluebunch wheatgrass, needle-and-thread, bluegrass, scattered bitterbrush, and sagebrush. Elevation ranges from 700 to 1,000 feet. The average annual precipitation is 8 to 10 inches, average annual air temperature is about 50° F., and the frost-free season is 180 to 195 days. These soils are associated mainly with Ellisforde, Quincy, and Pogue soils.

In a representative profile the surface layer is brown gravelly fine sandy loam 3 inches thick. The subsoil is yellowish-brown gravelly fine sandy loam, brown gravel-

ly loam, and dark yellowish-brown very gravelly sandy loam 16 inches thick. Coarse sand, gravel, and cobblestones are at a depth of 19 inches.

Malaga soils are used for orchards, vineyards, hay, pasture, range, and wildlife habitat.

Malaga gravelly fine sandy loam, 3 to 15 percent slopes (MaC).-This soil is on terraces. Slopes average 5 percent.

Representative profile, in an area 30 feet east of gravel pit, 1,600 feet north and 300 feet east of southwest corner of sec. 27, T. 22 N., R. 21 E., Chelan County:

A1-0 to 3 inches, brown (10YR 5/3) gravelly fine sandy loam, dark brown (10YR 3/3) moist; weak, thick, platy structure breaking to weak, fine, granular structure ; soft, friable, slightly sticky and nonplastic; 20 percent gravel ; many fine roots ; common very fine tubular pores ; slightly acid ; abrupt, smooth boundary.

B21-3 to 10 inches, yellowish-brown (10YR 5/4) gravelly fine sandy loam, dark yellowish brown (10YR 3/4) moist ; weak, coarse, prismatic structure ; slightly hard, friable, slightly sticky and nonplastic ; many fine roots ; common very fine tubular pores ; 20 percent gravel ; slightly acid; abrupt, smooth boundary.

B22-10 to 15 inches, brown (7.5YR 4/4) gravelly loam, dark brown (7.5YR 3/4) moist; weak, coarse, prismatic structure ; slightly hard, friable, slightly sticky and nonplastic ; common fine roots ; common very fine tubular pores; approximately 20 percent gravel; neutral ; abrupt, wavy boundary.

B3-15 to 19 inches, dark yellowish-brown (10YR 4/4) very gravelly sandy loam, dark yellowish brown (10YR 3/4) moist; massive; soft, friable, nonsticky and nonplastic ; few fine roots ; few fine tubular pores ; 70 percent gravel ; neutral ; abrupt, wavy boundary.

IIC-19 to 60 inches, coarse sand, gravel, and cobblestones.

The A horizon is 2 to 4 inches thick. It has a hue of 10YR or 7.5YR, a dry value of 4 or 5, and a dry chroma of 3 or 4. Moist value and chroma are 2 or 3. This horizon is 15 to 35 percent gravel. Its structure is weak, medium, prismatic or weak, thick, platy to weak, fine or coarse, granular. The B2 horizon is 10 to 16 inches thick. It has a dry hue of 10YR or 7.5YR. a value of 4 or 5, and a chroma of 4. When the soil is moist, hue ranges from 5YR to 10YR and is 7.5YR or redder in some places and value and chroma are 3 or 4. Texture in the B2 horizon is sandy loam or loam that is 15 to 35 percent gravel. Structure ranges from weak, fine, subangular blocky or weak, coarse, prismatic to massive. The B3 horizon is 3 to 10 inches thick. Thickness of the solum and depth to the IIC horizon range from 15 to 30 inches. Reaction is slightly acid to neutral throughout. Content of coarse fragments in the control section ranges from 50 to 75 percent, by weighted average.

Included with this soil in mapping were small areas of Ellisforde. Pogue, and Quincy soils and some areas of moderately deep soils.

Permeability is moderate to a depth of 15 inches and very rapid at depths below 19 inches. Runoff is slow to medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter or early in spring. The hazard of water erosion is slight to moderate. If this soil is irrigated, runoff is medium and the hazard of water erosion is moderate. The available moisture capacity is 3.5 to 4.0 inches.

This soil is used mainly for pasture and wildlife habitat. A small acreage is used for orchards. Capability unit VIe-1; not in a woodland suitability group, Sandy Loam range site ; orchard group 5.

Malaga gravelly fine sandy loam, 0 to 3 percent slopes (MaA).-This soil is on slightly hummocky terraces. It is similar to Malaga gravelly fine sandy loam, 3 to 15 percent slopes, except that it is 20 to 30 inches deep over open gravel and cobblestones.

Included with this soil in mapping were small areas where slopes are more than 3 percent and some areas where the soils are deeper than this soil.

Runoff is very slow, and the hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight.

This soil is used mainly for pasture and wildlife habitat. A small acreage is used for orchards. Capability unit VIe-1; not in a woodland suitability group ; Sandy Loam range site; orchard group 5.

Margerum Series

The Margerum series consists of well-drained, medium-textured soils that formed in wind-laid silt mixed with some pumice and volcanic ash. These soils are on uplands. Slopes are 0 to 45 percent. Where these soils are not cultivated, vegetation is mainly bluebunch wheatgrass. Idaho fescue, bluegrass, sagebrush, and scattered ponderosa pine. Elevation ranges from 1,800 to 2,800 feet. The average annual precipitation is 9 to 13 inches, average annual air temperature is 48° to 50° F., and the frost-free season is 160 to 180 days. These soils are associated mainly with Chelan, Entiat, Dinkelman, and Thow soils.

In a representative profile the surface layer is grayish-brown and pale-brown gravelly silt loam 24 inches thick. The subsoil is pale-brown gravelly silt loam and light yellowish-brown gravelly clay loam 20 inches thick. Glacial till is at a depth of 44 inches. Depth to granite bedrock is 60 inches or more.

Margerum soils are used mainly for dryfarmed cereal grain and pasture and forage.

Margerum gravelly silt loam, 8 to 15 percent slopes (MgC).-This soil is on uplands. Slopes average 10 percent.

Representative profile, in an area at a point halfway up ridge above small dray in the SE1/4NW1/4 sec. 21, T. 28 N. R. 22 E., Chelan County:

Ap-0 to 7 inches, grayish-brown (10YR 5/2) gravelly silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; common fine roots ; few fine tubular pores ; 18 percent pumice ; slightly acid; clear, smooth boundary.

A12-7 to 14 inches, grayish-brown (10YR 5/2) gravelly silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; common fine roots ; few fine tubular pores; 18 percent pumice ; slightly acid; clear, smooth boundary.

A3-14 to 24 inches, pale-brown (10YR 6/3) gravelly silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine roots ; few medium tubular pores ; 30 percent pumice ; neutral ; gradual, wavy boundary.

B1-24 to 35 inches, pale-brown (10YR 6/3) gravelly silt loam, dark brown (10YR 4/3) moist ; weak, fine, subangular blocky structure ; hard, friable, slightly sticky and slightly plastic ; common fine roots ; common to many medium tubular pores ; patchy thin clay films on ped surfaces ; 30 percent pumice ; neutral ; clear, wavy boundary.

B2t-35 to 44 inches, light yellowish-brown (10YR 6/4) gravelly clay loam, dark yellowish brown (10YR 4/4) moist ; moderate, very fine, subangular blocky structure ; very hard, firm, sticky and plastic ; few fine roots ; many medium tubular pores; common very thin and thin clay films in pores, common very thin clay bridges between mineral grains and few thin ,clay films on ped surfaces; 20 percent pumice; neutral ; clear, wavy boundary.

C 44 to 60 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak, fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; few fine roots ; few medium tubular pores; 10 percent pumice ; neutral.

Content of the dominantly pumiceous coarse fragments in the A and B horizons ranges from 15 to 35 percent. The A1 horizon is 12 to 16 inches thick. It has a dry value of 4 or 5, a moist value of 2 or 3, and a dry and moist chroma of 2 or 3. Its structure is weak or medium granular. Reaction in the Al horizon is neutral or slightly acid. The A3, B1, and B2 horizons each have a thickness of 8 to 12 inches. In the B2 horizon the dry value is 4 to 6. moist value is 3 or 4, and dry and moist chroma is 3 or 4. Texture in this horizon is gravelly clay loam to gravelly silt loam: structure is weak to moderate, blocky or prismatic ; and reaction is neutral or mildly alkaline. In the C horizon the color ranges are the same as those of the B2 horizon. Texture of the C horizon is silt loam or gravelly silt loam. This horizon is massive, or it is weak in structure. Reaction is neutral or mildly alkaline. In some places lenses consisting of more than .50 percent pumice are in the C horizon.

Included with this soil in mapping were small areas of Dinkelman and Chelan soils and some areas of moderately deep soils.

Permeability is moderately slow at a depth of 35 to 44 inches. Runoff is medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high. The available moisture capacity is 10 to 12 inches.

This soil is used mainly for dryfarmed cereal grain and forage. Capability unit IIIe-1; not in a woodland suitability group ; Loamy (L-2) range site ; orchard group 1.

Margerum gravelly silt loam, 0 to 8 percent slopes (MgB).- This soil is on uplands. Included in mapping were some areas where slopes are more than 8 percent.

Runoff is very slow to slow. and the hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow to medium and the hazard of erosion is slight to moderate.

This soil is used mainly for dryfarmed cereal grain and forage. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site, orchard group 1.

Margerum gravelly silt loam, 15 to 25 percent slopes (MgD).- This soil is on uplands. Included in mapping were small areas where slopes are less than 15 percent or more than 25 percent and some areas where bedrock is at a depth of 40 to 60 inches. These latter inclusions are in areas where this soil adjoins the Dinkelman soils.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mainly for dryfarmed cereal grain and forage. Capability unit IIIe-1; not in a woodland suitability group: Loamy (L-2) range site; orchard group 2.

Margerum gravelly silt loam, 25 to 45 percent slopes (MgE).- This soil is on uplands. Included in mapping were small areas where slopes are less than 25 percent and some areas where bedrock is at a depth of 40 to 60 inches. These latter inclusions are in areas where this soil adjoins the Dinkelman soils.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated. runof[f] is very rapid and the hazard of erosion is very high.

This soil is used mainly for dryfarmed cereal grain and pasture. Capability unit IVe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 2.

Morical Series

The Morical series consists of well-drained, moderately coarse textured soils that formed in place from weathered granodiorite and granite bedrock. These soils are on mountainous uplands. Slopes are 25 to 65 percent. Native vegetation is mainly ponderosa pine, scattered Douglas-fir, bluebunch wheatgrass, bluegrass, balsamroot, serviceberry, and some bitterbrush. Elevation ranges from 2,000 to 3,000 feet. The average annual precipitation is 15 to 35 inches, average annual air temperature is about 48° F., and the frost-free season is 100 to 145 days. These soils are associated mainly with Entiat, Dinkelman, and Stemilt soils.

In a representative profile the surface layer is light brownish-gray sandy loam 3 inches thick. The subsoil is pale-brown and light yellowish-brown sandy clay loam 19 inches thick. Decomposing granodiorite is at a depth of 22 inches.

Morical soils are used for woodland. range. and wildlife habitat.

Morical sandy loam, 25 to 65 percent slopes (MoF).-This soil is on mountainous uplands. Slopes average 30 percent.

Representative profile in an area 5 miles from second intersection on McKenzie Ridge Road. NW1/4NW1/4 sec. 6, T. 27 N., R. 21 E., Chelan County. This location is outside the Chelan Area. The soil profile is representative of Morical soils mapped within the survey area:

O1&O2-1 1/2 inches to 0, decomposing pine needles, grass, twigs, and leaves; neutral.

A1-0 to 3 inches, light brownish-gray (10YR 6/2) sandy loam, dark brown (10YR 3/3) moist; moderate subangular blocky structure ; slightly hard, friable, nonsticky and nonplastic ; common fine and medium roots ; many fine and medium tubular pores ; mildly alkaline; clear, wavy boundary.

B11-3 to 10 inches, pale-brown (10YR 6/3) sandy clay loam, dark brown (10YR 3/3) moist; strong subangular blocky structure : hard, firm, nonsticky and slightly plastic ; few fine, medium, and coarse roots ; many fine and medium tubular pores ; mildly alkaline ; gradual, wavy boundary.

B12-10 to 16 inches, pale-brown (10YR 6/3) sandy clay loam, dark yellowish brown (10YR 4/4) moist; strong subangular blocky structure; very hard, very firm, sticky and plastic ; few fine, medium, and coarse roots ; many fine and medium tubular pores; mildly alkaline; gradual, wavy boundary.

B2t-16 to 22 inches, light yellowish-brown (10YR 6/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist ; massive ; very hard, very firm, sticky and plastic ; few fine, medium, and coarse roots ; many

fuse and medium tubular pores; few, thin, patchy clay films on ped surfaces ; neutral ; diffuse, wavy boundary.

C-22 inches, decomposing granodiorite intermixed with inclusions of soil.

The A horizon is 2 to 5 inches thick. It has a value of 5 or 6 and a chroma of 2 or 3. Structure is moderate or strong. The B1 horizon is 9 to 17 inches thick, and the B2t horizon is 5 to 18 inches thick. The B2t horizon has a value of 5 to 7 and a chroma of 3 or 4. Texture is sandy clay loam or clay loam. Reaction is neutral to mildly alkaline throughout. Content of coarse fragments in the soil ranges from 5 to 35 percent, by volume. Depth to weathered granodiorite and thickness of the solum ranges from 20 to 40 inches.

Included with this soil in mapping were small areas of Entiat and Dinkelman soils and some areas of soils that are deeper or shallower than this Morical soil.

Permeability is moderately slow. Runoff is rapid to very rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is high to very high. The available moisture capacity is about 4 inches.

This soil is used mainly for woodland, range, and wildlife habitat. Capability unit VIIe-1; woodland suitability group 6d1; not in an orchard group or a range site.

Nard Series

The Nard series consists of well-drained, medium-textured soils that formed mainly in weathered arkose sandstone. They contain some loess, volcanic ash, and pumice. These soils are on mountainous uplands. Slopes are 8 to 65 percent. Native vegetation is Douglas-fir, ponderosa pine, lodgepole pine, vineleaf maple, willow, spirea, ceanothus, pinegrass, and ferns. Elevation ranges from 1,600 to 4,000 feet. The average annual precipitation is 25 to 35 inches, average annual air temperature is about 43° F., and the frost-free season is about 75 to 100 days. These soils are associated with Nevine, Varelum, Chiwawa, and Wintoner soils.

In a representative profile the surface layer is grayish-brown silt loam 3 inches thick. The subsoil is light yellowish-brown and pale-brown loam 21 inches thick. The substratum is pale-brown. heavy silt loam that extends to a depth of 60 inches.

Nard soils are used for woodland and wildlife habitat.

Nard silt loam, 45 to 65 percent slopes (NaF).-This soil is on mountainous uplands. Slopes average 55 percent.

Representative profile, in an area 500 feet west of north quarter corner of sec. 1. T. 26 N.. R. 17 E., Chelan County:

O1-1 inch to 0, duff of undecomposed needles and twigs.

A1-0 to 3 inches, grayish-brown (10YR 5/2) silt loam, dark brown (10Y R 3/3) moist; weak, fine and medium, granular structure : slightly hard, very friable, slightly sticky and slightly plastic ; many fine roots ; common fine tubular pores; 10 percent gravel and pumice ; neutral ; clear, wavy boundary.

B21-3 to 6 inches, light yellowish-brown (10YR 6/4) loam, dark brown (10YR 4/3) moist; weak, fine, subangular blocky structure : slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; few medium tubular pores; 10 percent gravel and pumice ; neutral ; clear, wavy boundary.

B22-6 to 24 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 4/3) moist; weak, fine and medium, subangular blocky structure ; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots ; few fine tubular pores ; 4 percent gravel ; neutral ; gradual, smooth boundary.

C-24 to 60 inches, pale-brown (10YR 6/3) heavy silt loam, dark brown (10YR 3/3) moist ; massive ; hard, firm, sticky and plastic ; few fine roots ; few fine tubular pores; 3 percent gravel; neutral.

The control section contains 20 to 40 percent pyroclastic material. It has less than 15 percent coarse fragments and is loam or silt loam that is 18 to 27 percent clay. Depth to bedrock ranges from 40 inches to more than 60 inches. Reaction is neutral or slightly acid throughout.

The A horizon is 2 to 4 inches thick. It has a dry value of 5 or 6, a moist value of 3, a dry chroma of 2, and a moist chroma of 1 to 3. Structure is weak, granular or blocky. The B horizon is 18 to 26 inches thick. It has a dry value of 6, a moist value of 3 or 9, and a dry and moist chroma of 3 or 4. Texture is loam or silt loam, and structure is weak blocky or prismatic. The C horizon has a dry value of 6 or 7, a moist value of 4 or 5, and a dry and moist chroma of 3 to 6. Texture is silt loam or loam.

Included with this soil in mapping were small areas of Nevine and Varelum soils and some areas where the surface layer is fine sandy loam.

Permeability is moderate. Runoff is very rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is very high. The available moisture capacity is 10 to 12 inches.

The soil is used mainly for woodland and wildlife habitat. Capability unit VIIe-1; woodland suitability group 3rl ; not in an orchard group or a range site.

Nard silt loam, 8 to 25 percent slopes (NaD).-This soil is on mountainous uplands. Included in mapping were small areas of steeper soils, some areas where sandstone is at a shallower depth than that in this soil, and some areas where the surface layer is fine sandy loam.

Runoff is medium, and the hazard of water erosion is moderate.

This soil is used mainly for woodland and wildlife habitat. Capability unit IVe-1; woodland suitability group 3o1; not in an orchard group or a range site.

Nard silt loam, 25 to 45 percent slopes (NaE).-This soil is on mountainous uplands. Included in mapping were small areas where slopes are less than 25 percent or more than 45 percent and some areas where the surface layer is fine sandy loam.

Runoff is rapid, and the hazard of water erosion is high.

This soil is used mainly for woodland and wildlife habitat. Capability unit VIe-1; woodland suitability group 3rl; not in an orchard group or a range site.

Nard-Rock outcrop complex, 25 to 65 percent slopes, eroded (NdF2).-This complex is on mountainous uplands. It is about 90 percent Nard silt loam, 25 to 65 percent slopes, and about 10 percent Rock outcrop.

Included with this complex in mapping were small areas where slopes are less than 25 percent, small areas of shallow soils, and some areas that have a surface laver of fine sandy loam.

Runoff is rapid and very rapid, and the hazard of water erosion is high to very high.

The soils in this complex are used mostly for woodland and wildlife habitat. Capability unit VIIs-1; woodland suitability group 4x2; not in an orchard group or a range site.

Nevine Series

The Nevine series consists of well-drained, moderately coarse textured soils that formed in pumice, volcanic ash, and some loess overlying glacial till. These soils are on mountainous uplands near Lake Wenatchee. Slopes are 0 to 45 percent. The native vegetation is mainly ponderosa pine, lodgepole pine, Douglas-fir, pinegrass, and spirea. Elevation ranges from 2,200 to 2,800 feet. The average annual precipitation is 30 to 40 inches, average annual air temperature is about 43° F., and the frost-free season is 80 to 120 days. These soils are associated mainly with Chiwawa, Nard, and Peoh soils.

In a representative profile the subsoil is pale-brown sandy loam and very pale brown sandy loam about 28 inches thick. The substratum is very pale brown gravelly loam and gravelly sandy loam that extends to a depth of 60 inches.

Nevine soils are used for woodland and wildlife habitat.

Nevine stony sandy loam, 0 to 25 percent slopes (NeD).-This soil is on foot slopes on mountainous uplands. Slopes average about 15 percent in the Lake Wenatchee Plain area.

Representative profile, in an area 1,350 feet north of south quarter corner of sec. 8, T. 26 N., R. 17 E., Chelan County:

O1-1 inch to 0, duff of undecomposed needles, twigs, and cones.

B21-0 to 10 inches, pale-brown (10YR 6/3) sandy loam, dark yellowish brown (10YR 3/4) moist; weak, fine, crumb structure ; loose, very friable, nonsticky and nonplastic ; many fine roots ; common fine and medium pores ; 14 percent pumice ; stones cover 0.01 percent of the surface ; neutral ; gradual, wavy boundary.

B22-10 to 28 inches, very pale brown (10YR 7/3) sandy loam, dark yellowish brown (10YR 4/4) moist; weak, medium, subangular blocky structure ; soft, friable, nonsticky and nonplastic ; common fine roots ; few fine tubular pores; 12 percent pumice; neutral; abrupt, wavy boundary.

IIC1-28 to 42 inches, very pale brown (10YR 7/3) gravelly loam, dark brown (10YR 4/3) moist; massive; soft, friable, slightly sticky and slightly plastic ; few fine roots ; few fine tubular pores ; few, prominent, dark yellowish-brown (10YR 4/4), moist bands 1/4 to 3/4 inch wide; 38 percent gravel and cobblestones; neutral ; clear, wavy boundary.

IIC2-42 to 60 inches, very pale brown (10YR 7/3) gravelly sandy loam, dark brown (10YR 4/3) moist ; massive; soft, friable, slightly sticky and slightly plastic: few fine roots ; few medium tubular pores ; few, prominent, dark yellowish-brown (10YR 4/4), moist bands 1/4 to 3/4 inch wide ; 38 percent gravel and cobblestones; neutral.

The upper part of the soil is more than 60 percent pyroclastic material. Content of coarse fragments ranges from 0 to 15 percent in the B2 horizon and from 35 to 60 percent in the IIC horizon. Reaction in the solum is neutral to slightly acid. An Al horizon is discontinuous. It has a dry value of 4 to 6, a moist value of 2 or 3, and a dry and moist chroma of 2 or 3. Texture is silt loam to loam. An A2 horizon is discontinuous and has a dry value of 6 or 7, a moist value of 4 or 5, and a dry and moist chroma of 2. The B horizon is 24 to 33 inches thick. It has a dry value of 6 or 7 and a moist value and dry chroma of 3- or 4. Texture is silt loam to loam or sandy loam. The C horizon has a dry value of 6 or 7, a moist value of 4 or 5, a dry and moist chroma of 2 to 4, and a hue of 10YR or 2.5Y. Texture is gravelly loam to gravelly sandy loam. The IIC1 horizon is 12 to 18 inches thick.

Included with this soil in mapping were small areas of Nard and Chiwawa soils. Also included were small areas where slopes are more than 25 percent and some areas where the surface is nonstony.

Permeability is moderate. Runoff is very slow to medium. host runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is slight to moderate. The available moisture capacity is 7 to 8 inches.

The soil is used mainly for woodland and wildlife habitat. Capability unit VIe-1; woodland suitability group 3o2; not in an orchard group or a range site.

Nevine stony sandy loam, 25 to 45 percent slopes (NeE).-This soil is on foot slopes on mountainous uplands in the Lake Wenatchee-Plain area.

Included with this soil in mapping were small areas where slopes are less than 25 percent and some areas that are free of stones.

Runoff is rapid, and the hazard of water erosion is high.

This soil is used mainly for woodland and wildlife habitat. Capability unit VIe-1; woodland suitability group 3r1; not in an orchard group or a range site.

Peoh Series

The Peoh series consists of poorly drained, medium-textured soils that formed in old alluvium but have an admixture of loess and volcanic ash in the surface layer. These soils are on terraces and in depressions on uplands. Slopes are 0 to 3 percent. Where these soils are not cultivated, vegetation is mainly willow, alder, scattered Douglas-fir and ponderosa pine, wetland grasses and sedges, and various forbs. Elevation ranges from 800 to 1.500 feet. The average annual precipitation is 15 to 25 inches, average annual air temperature is 46° to 50° F., and the frost-free season is 130 to 165 days. These soils
are associated mainly with Leavenworth, Burch, Brief, and Varelum soils.

In a representative profile the surface layer is grayish-brown silt loam 16 inches thick, the subsoil is grayish-brown clay loam 16 inches thick, and the substratum is grayish-brown sandy clay loam that extends to a depth of 60 inches.

Peoh soils are used mainly for pasture and hay.

Peoh silt loam (Pe).-This soil is on terraces and in depressions on uplands. Slopes average 2 percent. Representative profile in an area 50 feet east of road, one-half mile north of Leavenworth in the NW1/4SE1/4 sec. 1, T. 24 N., R. 17 E., Chelan County:

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

A12-6 to 16 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine fibrous roots : few fine tubular pores ; neutral ; abrupt, wavy boundary.

B2g-16 to 32 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; common, medium, distinct, dark yellowish-brown (10YR

4/4) mottles ; massive ; hard, friable, sticky and plastic ; few fine fibrous roots ; very few fine tubular pores; neutral; gradual, wavy boundary.

C-32 to 60 inches, grayish-brown (10YR 5/2) sandy clay loam, grayish brown (10YR 5/2) moist; common, medium, dark yellowish-brown (10YR 4/4) and gray (2.5YR 5/0) mottles; massive; hard, friable, sticky and plastic ; very few roots; very few fine tubular pores; neutral.

The A horizon ranges from 12 to 20 inches in thickness. It has a dry value of 4 or 5, a moist value of 2 or 3, and a dry and moist chroma of 1 or 2. Structure is weak, granular or blocky. The B2g horizon is 12 to 20 inches thick. It has a dry value of 5 or 6, a moist value of 3 or 4, and a dry and moist chroma of 1 or 2 ; and it is mottled. Texture is clay loam or sandy clay loam. Structure of the B2g horizon is weak or massive. The C horizon has a hue of 10YR or 2.5Y, a dry value of 5 or 6, a moist value of 4 or 5, and a dry and moist chroma of 1 or 2. Texture is sandy clay loam or clay loam. Reaction is slightly acid or neutral throughout, but it becomes less acid with increasing depth.

Included with this soil in mapping were small areas of Burch and Brief soils and some areas of soils that are steeper than this soil. Also included were small areas of soils that have a thin surface lamer of muck.

Permeability is slow. Runoff is ponded to very slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight. The available moisture capacity is 10 to 12 inches. A seasonal high water table is at a depth of 0 to 2 feet.

This soil is used mainly for pasture and hay. Capability unit IIIw-2; Wet Meadow range site; not in an orchard group or a woodland suitability group.

Peshastin Series

The Peshastin series consists of well-drained, medium-textured soils that formed in nonsorted glacial till. The till is mostly gravel and cobblestones of granite. schist, gneiss, basalt, and sandstone. Some ice-rafted, bouldery deposits are also present. These soils are on terraces. Slopes are 0 to 45 percent. Where these soils are not cultivated. vegetation is mainly needle-and-thread, bluebunch wheatgrass, bluegrass, big sagebrush, and scattered ponderosa pine. Elevation ranges from 700 to 1,000 feet. The average annual precipitation is 8 to 15 inches, the average annual air temperature is about 50° F., and the frost-free season is 175 to 190 days. These soils are associated mainly with Pogue, Wenatchee, and Burch soils.

In a representative profile the surface layer is grayish-brown loam that is stony in places. It is 7 inches thick. Below this layer is brown loam 11 inches thick. The substratum is light brownish-gray very cobbly sandy loam that extends to a depth of 60 inches.

Peshastin soils are used for pasture, orchards, and wildlife habitat.

Peshastin loam, 3 to 8 percent slopes (PhB).-This soil is on terraces. Slopes average 5 percent (fig. 9).

Representative profile, in the middle and on the west side of a small railroad cut in the NE1/4NE1/4 sec. 29, T. 22 N., R. 21 E., Chelan County:

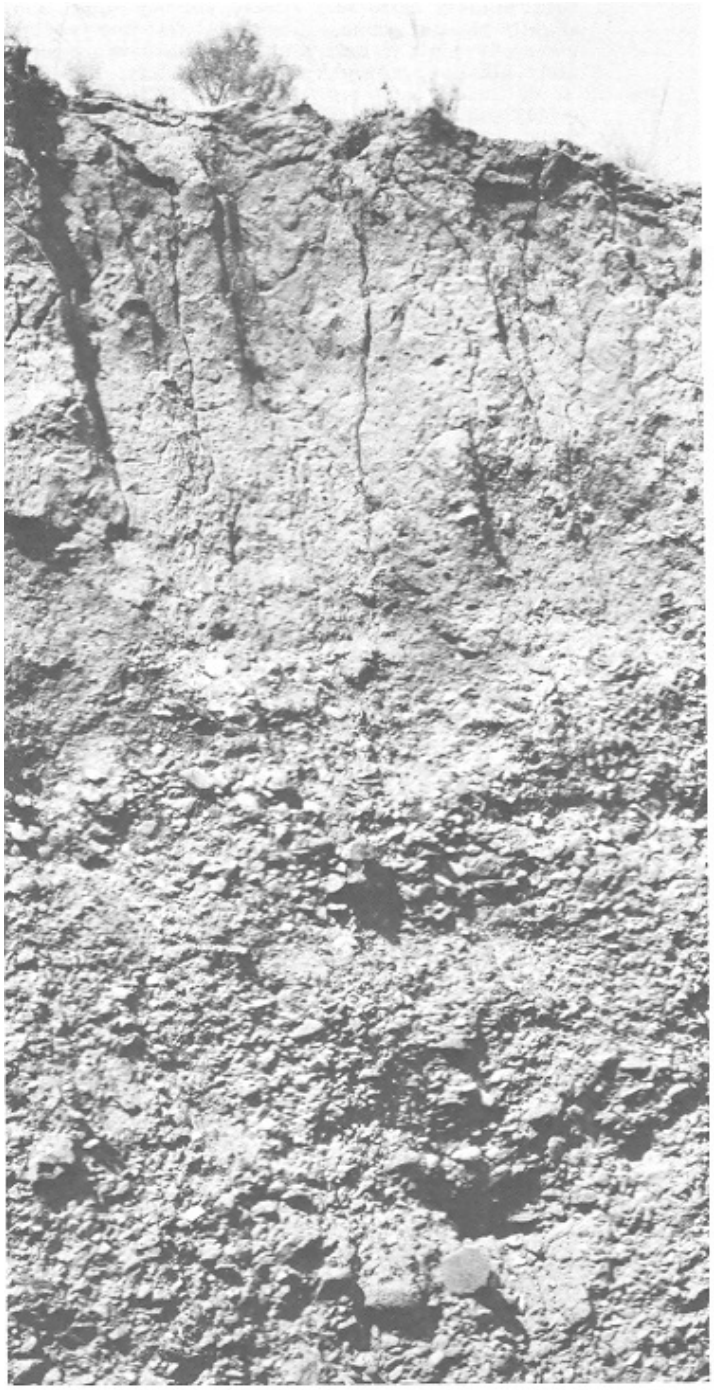

Figure 9.-An area of Peshastin loam, 3 to 8 percent slopes. medium-textured surface layer and subsoil over calcareous very cobbly sandy loam substratum.

A1-0 to 7 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak, thin, platy structure ; slightly hard, very friable, slightly sticky and slightly plastic, common fine roots ; few fine tubular pores ; 5 percent gravel and cobblestones ; mildly alkaline ; abrupt, smooth boundary.

AC-7 to 18 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) moist ; weak, medium, prismatic struc-

ture ; slightly bard, very friable, slightly sticky and slightly plastic ; common fine roots ; few fine tubular pores; 10 percent gravel and cobblestones; moderately alkaline ; abrupt, smooth boundary.

Cca-18 to 60 inches, light brownish-gray (10YR 6/2) very cobbly sandy loam, dark grayish brown (10YR 4/2) moist ; massive ; slightly hard, very friable, nonsticky and nonplastic ; few fine roots ; few medium tubular pores ; some accumulations of lime on underside of cobblestones and stones at a depth of 18 to 20 inches ; 75 percent cobblestones, gravel, and stones ; moderately alkaline.

The A1 horizon is 6 to 10 inches thick. It has a dry value of 3 to 5, a moist value of 2 or 3, and a dry and moist chroma of 2. Structure is weak, platy or granular. The AC horizon is 10 to 12 inches thick. It has a dry value of 4 to 6, a moist value of 3 or 4, and a dry and moist chroma of 2 to 4. Texture is loam or sandy loam, but the material is gravelly or cobbly in places. The AC horizon is massive, or structure is weak, blocky or prismatic. The C horizon has a hue of 10YR or 2.5Y, a value of 4 to 6, and a chroma of 2 to 4. Texture is very cobbly sandy loam or very gravelly sandy loam. Depth to secondary carbonates ranges from 16 to 22 inches.

Included with this soil in mapping were small areas of Pogue, Wentachee, and Burch soils and some areas where the surface layer is stony.

Permeability is moderate to a depth of 18 inches and moderately rapid below. Runoff is slow. Most runoff occurs during severe thunderstorms and when snow melts in winter and early in spring. The hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate. The available moisture capacity is 5 to 6 inches.

This soil is used mainly for pasture and orchards. Capability unit IIIe-1; not in a woodland suitability group, Loamy (L-2) range site; orchard group 1.

Peshastin loam, 8 to 15 percent slopes (PhC).-This soil is on terraces. Included in mapping were small areas where slopes are less than 8 percent and more than 15 percent.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high.

This soil is used for pasture and orchards. Capability unit IIIe-1; not in a woodland suitability group ; Loamy (L-2) range site; orchard group 1.

Peshastin stony loam, 0 to 25 percent slopes (PlD).-This soil is on terraces. It is similar to Peshastin loam, 3 to 8 percent slopes, except that it has stones on the surface and mixed throughout the soil.

Included with this soil in mapping were small areas where slopes are more than 25 percent.

Runoff is slow to medium, and the hazard of water erosion is slight to moderate. If this soil is irrigated, runoff is slow to very rapid and the hazard of erosion is slight to very high.

This soil is used for pasture and orchards. Capability unit VIe-1; not in a woodland suitability group ; Loamy (L-2) range site; orchard group 5.

Peshastin stony loam, 25 to 45 percent slopes (PlE).-This soil is on terraces. It is similar to Peshastin loam, 3 to 8 percent slopes, except that it has stones on the surface and mixed throughout the soil.

Included with this soil, in mapping were small areas where slopes are less than 25 percent.

Runoff is rapid, and the hazard of water erosion is high.

This soil is used mainly for pasture. Capability unit VIe-1; Shallow (S-2) range site; not in an orchard group or a woodland suitability group.

Pogue Series

The Pogue series consists of somewhat excessively drained, moderately coarse textured soils that formed in glacial outwash derived mainly from quartz-bearing rocks. These soils are on terraces near the Columbia River. Slopes are 0 to 45 percent. Where these soils are not cultivated, vegetation is mainly big sagebrush, needle-and-thread, bluebunch wheatgrass, bluegrass, and bitterbrush. Elevation ranges from 700 to 1,000 feet. The average annual precipitation is 8 to 12 inches, average annual air temperature is 50° F., and the frost-free season is 175 to 190 days. These soils are associated mainly with Burch, Cashmere, Cashmont, and Peshastin soils.

In a representative profile the surface layer is grayish-brown fine sandy loam that is gravelly or very stony in places. It is 6 inches thick. The subsoil is brown fine sandy loam 11 inches thick. The substratum is brown gravelly fine sandy loam 13 inches thick. Outwash sand and gravel underlie these soils at a depth of 30 inches. Pogue soils are used for orchards, hay, range, pasture, and wildlife habitat.

Pogue fine sandy loam, 3 to 8 percent slopes (PoB).-This soil is on terraces. Slopes average 5 percent.

Representative profile, in an area 1,600 feet north and 1,000 feet east of the southwest corner of sec. 5, T. 21 N., R. 22 E., Chelan County:

A1-0 to 6 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist ; weak, coarse, prismatic structure ; slightly hard, friable, slightly sticky and slightly plastic ; many microtubular pores; many fine roots; neutral; gradual, wavy boundary.

B2-6 to 17 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure ; slightly hard, friable, slightly sticky and slightly plastic ; many microtubular pores ; approximately 5 percent gravel ; common fine roots ; neutral; gradual, wavy boundary.

IIC1-17 to 30 inches, brown (10YR 5/3) gravelly fine sandy loam, dark brown (10YR 3/3) moist; massive; soft, very friable, slightly sticky and slightly plastic ; few fine roots ; common very fine tubular pores ; approximately 40 percent gravel ; neutral ; abrupt, smooth boundary.

IIC2-30 to 60 inches, outwash sand and gravel.

The A horizon ranges from 4 to 8 inches in thickness. It has a moist value of 3 or 4 and a dry and moist chroma of 2 or 3. Structure is weak, coarse, prismatic, weak, thick, platy, or weak, fine, granular. The B horizon is 8 to 14 inches thick. It has a moist value and chroma of 3 or 4. Structure ranges from weak, coarse, prismatic to weak, fine, granular. or the horizon is massive. The C horizon has a moist chroma of 3 or 4. Depth to outwash sand, gravel, and cobblestones ranges from 20 to 36 inches. The IIC1 horizon is 8 to 14 inches thick.

Included with this soil in mapping were small areas of Burch and Cashmont soils and some areas where the surface layer is cobbly or stony.

Permeability is moderate to the depth of the IIC2 horizon and very rapid below. Runoff is slow. Most run-

off occurs during severe thunderstorms and when snow melts rapidly in winter or early in spring. The hazards of soil blowing and water erosion are slight. If this soil is irrigated, runoff is medium and the hazard of water erosion is moderate. The available moisture capacity is 5 to 6 inches.

This soil is used mainly for irrigated orchards. A small acreage is in hay and pasture. Capability unit IVe-1; Sandy Loam range site; not in a woodland suitability group ; orchard group 3.

Pogue fine sandy loam, 8 to 15 percent slopes (PoC).-This soil is on terraces. Included in mapping were small areas where slopes are less than 8 percent or more than 15 percent and some areas where the surface layer is gravelly.

Runoff is medium, and the hazard of soil blowing and water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of water erosion is high.

This soil is used mainly for orchards. Capability unit IVe-1; not in a woodland suitability group ; Sandy Loam range site: orchard group 3.

Pogue gravelly fine sandy loam, 3 to 8 percent slopes (PrB).-This soil is on terraces. It occupies slightly higher positions on the landscape than Pogue fine sandy loams.

Included with this soil in mapping were small areas where slopes are less than 3 percent or more than 8 percent and some areas where the soil is nongravelly.

Runoff is slow, and the hazards of soil blowing and water erosion are slight. If this soil is irrigated, runoff is medium and the hazard of water erosion is moderate. The available moisture capacity is about 3 inches.

This soil is used mainly for orchards, hay, and pasture. Capability unit IVe-1; Sandy Loam range site; not in a woodland suitability group; orchard group 5.

Pogue gravelly fine sandy loam, 8 to 15 percent slopes (PrC).-This soil is near the edges of and along dissected drainageways of hummocky terraces. Included in mapping were small areas where slopes are less than 8 percent or more than 15 percent and some areas where the soil is nongravelly.

Runoff is medium, and the hazards of soil blowing and water erosion are moderate. If this soil is irrigated, runoff is rapid and the hazard of water erosion is high.

This soil is used mainly for orchards, hay, and pasture. Capability unit IVe-1; Sandy Loam range site; not in a woodland suitability group; orchard group 5.

Pogue gravelly fine sandy loam, 15 to 25 percent slopes (PrD).-This soil is near the edges of and along dissected drainageways and hummocky terraces. Included in mapping were small areas where slopes are less than 15 percent or more than 25 percent and some areas where the soil is nongravelly.

Runoff is medium, and the hazards of soil blowing and water erosion are moderate. If this soil is irrigated, runoff is very rapid and the hazard of water erosion is very high.

This soil is used mainly for orchards, hay, and pasture. Capability unit IVe-1; Sandy Loam range site; not in a. woodland suitability group; orchard group 5.

Pogue gravelly fine sandy loam, 25 to 45 percent slopes (PrE).-This soil is on terrace breaks and also near the edges of and along dissected drainageways of hummocky terraces.

Included with this soil in mapping were small areas where slopes are less than 25 percent and some where the soil is nongravelly.

Runoff is rapid, the hazard of soil blowing is moderate, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of water erosion is very high.

This soil is used mainly for range and wildlife habitat. Capability unit. VIe-1; not in a woodland suitability group; Sandy Loam range site; orchard group 5.

Pogue very stony fine sandy loam, 0 to 45 percent slopes (PsE).-This soil is on terrace remnants and along dissected drainageways of hummocky terraces. It is similar to Pogue fine sandy loam. 3 to 8 percent slopes, except that the soil is stony throughout.

Included with this soil in mapping were small areas where the surface layer is gravelly. Also included were some very bouldery areas. Most of these are areas immediately north of the town of Entiat.

Runoff is slow to rapid, the hazard of soil blowing is slight, and the hazard of water erosion is slight to high. The available moisture capacity is 4 to 5 inches.

This soil is used for range and wildlife habitat. Capability unit VIs-1; Sandy Loam range site; not in an orchard group or a woodland suitability group.

Quincy Series

The Quincy series consists of somewhat excessively drained, coarse-textured soils -that formed in fine sand deposited by wind. These soils are on terraces near the Columbia River. Slopes are 0 to 15 percent. Where these soils are not cultivated, vegetation is mainly needle-and-thread, Indian ricegrass, bluebunch wheatgrass, big sagebrush, and bitterbrush. Elevation ranges from 600 to 1,200 feet. The average annual precipitation is 7 to 12 inches, average annual air temperature is 49° to 51° F., and the frost-free season is 180 to 195 days. These soils are associated mainly with Pogue, Burch, and Cashmere soils.

In a representative profile the surface layer is grayish-brown loamy fine sand 10 inches thick. The substratum is light brownish-gray fine sand that extends to a depth of 60 inches.

Quincy soils are used for orchards, hay, and pasture.

Quincy loamy fine sand, 0 to 15 percent slopes (QuC).-This soil is on terraces near the Columbia River. Slopes average 5 percent.

Representative profile, in a cherry orchard, 740 feet cast of south quarter corner of sec. 22, T. 23 N., R. 20 E., Douglas County. This location is immediately across the Columbia River from the Chelan County Area. The soil profile is representative of Quincy soils mapped within this survey area:

Ap-0 to 10 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, medium, platy structure ; soft, very friable, nonsticky and nonplastic ; common fine roots ; few fine tubular pores ; mildly alkaline ; clear, smooth boundary.

C-10 to 60 inches, light brownish-gray (10YR 6/2) fine sand, dark grayish brown (10YR 4/2) moist; single grain ; loose, nonsticky and nonplastic ; common fine

roots to a depth of 30 inches and a few to a depth of 48 inches ; very few fine tubular pores ; moderately alkaline.

The A horizon ranges from 8 to 12 inches in thickness. It has a dry and moist chroma of 2 or 3. In places it has weak, fine or moderate, crumb structure or weak, medium, platy structure. In places the A horizon consists of fine sand. In places the C horizon is stratified loamy fine sand and sand. In other places the soil is underlain by old alluvium, lacustrine deposits, outwash gravel, or deposits of ablation glacial till. Large boulders are in some small areas.

Included with this soil in mapping were small areas of Cashmere and Pogue soils.

Permeability is rapid. Runoff is very slow to slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of blowing is high, and the hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow to medium and the hazard of water erosion is slight to moderate. The available moisture capacity is 4 to 5 inches.

This soil is used mainly for orchards, hay, and pasture. Capability unit VIIe-1; not in a woodland suitability group; Sandy range site; orchard group 1.

Ritzville Series

The Ritzville series consists of well-drained, medium-textured soils that formed in wind-laid silt over basalt bedrock. These soils are on rather broad ridgetops on uplands. Slopes are 0 to 45 percent. Where these soils are not cultivated, vegetation is mainly bluebunch wheatgrass. Idaho fescue, bluegrass, and sagebrush. Elevation ranges from 1,000 to 2,800 feet. The average annual precipitation is 9 to 12 inches, average annual air temperature is about 49° F., and the frost-free season is 160 to 175 days. These soils are associated mainly with Cowiche, Colockum, and Zen soils.

In a representative profile the surface layer is grayish-brown silt loam 10 inches thick. The subsoil is grayish-brown and dark yellowish-brown silt loam 35 inches thick. The substratum is yellowish-brown heavy silt loam to a depth of 60 inches.

Ritzville soils are used mainly for dryfarmed cereal grain, hay, pasture, range, and wildlife habitat. A small acreage is in orchards.

Ritzville silt loam, 0 to 8 percent slopes (ReB).-This soil is on broad ridgetops on uplands. Slopes average 7 percent.

Representative profile, in an area 1,600 feet south and 1,000 feet west of northeast corner of sec. 15, T. 21 N.. R. 21 E., Chelan County:

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

B1-10 to 27 inches, grayish-brown (10YR 5/2) to brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, medium, prismatic structure ; slightly hard, friable, slightly sticky and slightly plastic ; common fine roots ; few fine tubular pores ; neutral ; gradual, smooth boundary.

B2-27 to 45 inches, dark yellowish-brown (10YR 4/4) heavy silt loam, dark brown (10YR 4/3) moist; moderate, medium, prismatic structure ; hard, sticky and plastic ; few fine roots ; few fine and medium tubular pores ; neutral ; clear, wavy boundary.

Cca-45 to 60 inches, yellowish-brown (10YR 5/4) heavy silt loam, dark brown (10YR 4/3) moist; moderate, medium, prismatic structure parting to massive ; very hard, firm, sticky and plastic ; few fine roots ; few fine and medium tubular pores ; weakly calcareous ; moderately alkaline.

The Ap horizon ranges from 8 to 12 inches in thickness and from silt loam to very fine sandy loam. Depth to lime ranges from 3 to 4 feet. The B horizon is 30 to 40 inches thick. The profile contains 0 to 10 percent pumice through out. Depth to bedrock is 40 to 60 inches or more.

Included with this soil in mapping were small areas of Zen and Colockum soils. Also included were small areas that are shallow and rocky.

Permeability is moderate. Runoff is slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is slight. If this soil is irrigated, runoff is slow to medium and the hazard of erosion is slight to moderate. The available moisture capacity is about 10 to 12 inches.

This soil is used mainly for dryfarmed wheat, oats, and barley. It is also used for orchards, range, pasture, and wildlife. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 1.

Ritzville silt loam, 8 to 15 percent slopes (ReC).-This soil is on broad upland ridgetops. Included in mapping were small areas where slopes are less than 8 percent or more than 15 percent. Also included were small areas of soils that are shallower than this soil.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high.

This soil is used mainly for dryfarmed wheat, oats, and barley. Capability trait IIIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 1.

Ritzville silt loam, 15 to 25 percent slopes (ReD).-This soil is on ridgetops and side slopes on uplands. Included in mapping were small areas where slopes are less than 15 percent. Also included were small areas of soils that are shallower than this soil.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mainly for dryfarmed wheat, oats, and barley. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) range site; orchard group 2.

Ritzville silt loam, 25 to 45 percent slopes (ReE).-This soil is on ridges on uplands. Included in mapping were small areas where slopes are less than 25 percent or more than 45 percent. Also included were small areas of soils that are shallower than this soil.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mainly for dryfarmed wheat, oats, and barley and for range. Capability unit IVe-1; not in

a woodland suitability group; Loamy (L-2) or North Exposure (N-1) range site; orchard group 2.

Riverwash

Riverwash (Rh) consists of nearly level to gently sloping areas of water-washed cobblestones, gravel, and sand bass that are exposed along streams and rivers during the normal period of low water. Willows and cottonwoods grow in some of these areas, but most areas are nearly bare of vegetation. The areas of Riverwash are used as wildlife habitat, and they have value as a source of sand and gravel. Riverwash is associated with Beverly, Leavenworth, and Brief soils and Alluvial land. Capability unit VIIIs-1; not in a woodland suitability group, a range site, or an orchard group.

Rock Land

Rock land (Rk) consists of 25 to 90 percent rock outcrop. The rest is about 60 percent shallow and very shallow soils and 40 percent moderately deep to deep soils. Slopes are 8 to 70 percent. The outcrop is sandstone, basalt, granite, schist, or gneiss. Some talus areas of stones and boulders and small areas of deep, shaly, and gravelly material are also present (fig. 10).

This land type is mostly along the valley from Cashmere to Leavenworth and on hillsides that border the Columbia River. It is associated with Rock outcrop, Bjork-Rock outcrop complex, and Entiat-Rock outcrop complex.

Rock land is used mostly for range and wildlife habitat. Capability unit VIIs-1; Shallow (S-2) or Very Shallow range site ; not in a woodland suitability group or an orchard group.

Rock Outcrop

Rock outcrop (Ro) consists of nearly level to very steep areas of rock outcrop on escarpments and colluvial foot slopes. Some slopes are more than 90 percent. Basalt, sandstone, granite. gneiss. and schist are the major types of exposed bedrock. Vegetation consists of very sparse stands of bunchgrass an d brush. This land type is used to a limited degree by wildlife. especially chukars and quail. Areas of Rock outcrop are scattered throughout the survey area. Rock outcrop is associated with Rock land, Bjork-Rock outcrop complex, and Entiat-Rock outcrop complex. Capability unit VIIIs-1; not in a woodland suitability group, a range site, or an orchard group.

Stemilt Series

The Stemilt series consists of well-drained, medium-textured soils that formed in cobble.- and stony glacial till that is mainly of sandstone origin. These soils are on mountainous uplands. Slopes are 0 to 45 percent. Native vegetation consists of ponderosa pine, scattered Douglas-fir, pinegrass, sedge, bluebunch wheatgrass. Idaho fescue, common forbs, and scattered shrubs. Elevation ranges from 2,000 to 3,700 feet. The average annual precipitation is 16 to 22 inches, average annual air temperature is 46° F., and the frost-free season is 75 to 100 days. These soils are associated mainly with Colockum, Loneridge, and Tronsen soils.

Figure 10.-An area of Rock land on southeast-facing slope, showing many sandstone rock outcrops and areas of shallow soils.

In a representative profile the surface layer is dark ravish-brown silt loam 5 inches thick. The subsoil is brown silt loam and pale-brown and brown very cobbly silty clay loam that extends to a depth of 60 inches.

Stemilt soils are used for woodland, grazing, and wildlife habitat.

Stemilt silt loam, 0 to 25 percent slopes (StD).-This soil is on side slopes and broad ridgetops on mountainous uplands. Slopes average 10 percent.

Representative profile, in an area along Stemilt Hill Road, 600 feet east and 500 feet north of southwest corner of sec. 13, T. 21 N., R. 20 E., Chelan County

O1&O2-1 inch to 0, loose, partly decomposed and decomposed organic litter of needles, twigs, and leaves.

A1--0 to 5 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, thin, platy structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; many very fine tubular pores ; 5 percent cobblestones ; neutral ; clear, smooth boundary.

B1-5 to 17 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots; many very fine tubular pores; 10 percent cobblestones and gravel; neutral; clear, wavy boundary.

B2t-17 to 38 inches, brown (10YR 5/3) very cobbly silty clay loam, dark yellowish brown (10YR 3/4) moist: moderate, fine, subangular blocky structure ; hard, firm, very sticky and very plastic ; common fine roots; many very fine tubular pores; 60 percent cobblestones and gravel; very few thin clay films on ped surfaces ; neutral ; gradual, wavy boundary.

B3t-38 to 60 inches, pale-brown (10YR 6/3) very cobbly silty clay loam, dark yellowish brown (10YR 4/4) moist ; massive ; very hard, firm, very sticky and very plastic ; few fine roots ; common very fine tubular pores; 75 percent cobblestones and gravel; common thin clay films in pores and on ped surfaces ; neutral.

Depth to bedrock and thickness of the solum range from 40 inches to more than 60 inches. Reaction is mildly alkaline or neutral throughout. The A horizon ranges from 3 to 7 inches in thickness. It has a dry value of 4 or 5, a moist value of 3, and a dry and moist chroma of 2 or 3. This horizon has weak or moderate, granular, platy, or blocky structure. The B1 horizon is 10 to 15 inches thick. The B2t horizon is 18 to 24 inches thick. It has a dry value of 5 or 6, a moist value of 3 or 4, and a dry and moist chroma of 3 or 4. Texture is silty clay loam or clay loam that is cobbly or very cobbly. The B2t horizon has moderate to strong, blocky or prismatic structure. The B2t horizon, where present, is 35 to 65 percent coarse fragments and 25 to 35 percent clay. It lacks a contrasting texture within a depth of 40 inches.

Included with this soil in mapping were small areas of Colockum, Loneridge, and Tronsen soils. Also included were areas that have stones on the surface.

Permeability is slow. Runoff is slow to medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is slight to moderate. The available moisture capacity is 6 to 7 inches.

This soil is used for woodland, wildlife habitat, and range. Capability unit IVe-1; woodland suitability group 5o1; not in an orchard group or a range site.

Stemilt silt loam, 25 to 45 percent slopes (StE).-This soil is on side slopes of broad mountain terraces. Included in mapping were small areas where slopes are less than 25 percent or more than 45 percent and some that are stony.

Runoff is rapid, and the hazard of erosion is high.

This soil is used mainly for woodland, wildlife habitat, and range. Capability unit VIe-1; woodland suitability group 5r1; not in an orchard group or a range site.

Supplee Series

The Supplee series consists of well-drained, medium-textured soils that formed in pumice, volcanic ash, and deposits of loess over gravelly and cobbly glacial outwash. These soils are on terraces near the Columbia River. Slopes are 0 to 45 percent. Where these soils are not cultivated, vegetation is mainly bluebunch wheatgrass, needle-and-thread, bluegrass, bitterbrush, and sagebrush. Elevation ranges from 1,100 to 1,300 feet. The average annual precipitation is 10 to 13 inches, average annual air temperature is about 48° F., and the frost-free season is 180 to 200 days. These soils are associated mainly with Chelan, Pogue, and Entiat soils.

In a representative profile the surface layer is grayish-brown very fine sandy loam 6 inches thick. The subsoil is brown gravelly fine sandy loam and very gravelly sandy loam 25 inches thick. The substratum is glacial outwash material of sand, gravel, and cobblestones at a depth of 31 inches. It extends to a depth of 60 inches and more.

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

Supplee very fine sandy loam, 0 to 3 percent slopes (SuA).-This soil is on terraces near the Columbia River. Slopes average 2 percent.

Representative profile, in an area 400 feet south and 100 feet east of northwest corner of sec. 34:,.T. 28 N., R. 23 E., Chelan County:

Ap-0 to 6 inches, grayish-brown (10YR 5/2) very fine sandy loam, very dark grayish brown (10YR 3/2) moist ; weak, thick, platy structure parting to weak, fine, granular structure ; slightly hard, very friable, slightly sticky and slightly plastic ; many fine roots ; common fine tubular pores ; approximately 10 percent pumice ; neutral ; gradual, smooth boundary.

B1-6 to 18 inches, brown (10YR 5/3) gravelly fine sandy loam, dark brown (10YR 3/3) moist ; weak, coarse, prismatic structure ; slightly hard, very friable, nonsticky and nonplastic ; common fine roots ; many fine tubular pores ; approximately 30 percent pumice ; mildly alkaline ; gradual, smooth boundary.

B2-18 to 31 inches, brown (10YR 5/3) very gravelly sandy loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure ; slightly hard, very friable, nonsticky and nonplastic ; few fine roots ; very few fine tubular pores ; approximately 60 percent pumice ; moderately alkaline ; abrupt, smooth boundary.

IICsica-31 to 60 inches, very gravelly sand ; single grain ; loose ; 75 percent pebbles and cobblestones ; silica and lime coating on underside of pebbles and cobblestones.

The A and B horizons are 60 to 80 percent pyroclastic that is 30 to 70 percent pumice, by volume, some ash, and as much as 20 percent nonpumiceous gravel. The A horizon has weak, granular or platy structure. The A1 or Ap horizon is 4 to 8 inches thick. It has a dry value of 4 or 5, a moist value of 2 or 3, and a dry and moist chroma of 2 or 3. The B horizon is 20 to 28 inches thick. It has a dry value of 5 or 6, a moist value of 3 or 4, and a dry and moist chroma of 2 or 3. Texture is very fine sandy loam or sandy loam that is gravelly or very gravelly. The gravel is dominantly pumice. Structure in the B horizon is weak, prismatic or blocky, or the material is massive. The IIC horizon has mixed

mineralogy and is more than 50 to 80 percent nonpumiceous coarse fragments. The IICsica horizon is very cobbly or very gravelly sand that has silica and lime coatings on the underside of the pebbles and cobblestones. Depth to the lithologic discontinuity and secondary carbonates ranges from 24 to 36 inches. Reaction ranges from neutral to mod
erately alkaline throughout.

Included with this soil in mapping were small areas of Chelan and Pogue soils and some soils that have a gravelly surface layer.

Permeability is moderate to a depth of 31 inches and rapid below that depth. Runoff is very slow. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight. The available moisture capacity is 6 to 7 inches.

This soil is used mainly for orchards and hay. Capability unit IVe-1; not in a woodland suitability group ; Sandy Loam range site; orchard group 3.

Supplee very fine sandy loam, 3 to 8 percent slopes (SuB).-This soil is on terraces. Included in mapping were small areas where slopes are less than 3 percent or more than 8 percent.

Runoff is slow, and the hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate.

This soil is used mostly for orchards and hay. Capability unit IVe-1; not in a woodland suitability group ; Sandy Loam range site; orchard group 3.

Supplee very fine sandy loam, 8 to 15 percent slopes (SuC).-This soil is near the edges of and along the dissected drainageways of terraces. Included in mapping were small areas where slopes are less than 8 percent or more than 15 percent.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high.

This soil is used mainly for orchards and hay. Capability unit IVe-l ; not in a woodland suitability group ; Sandy Loam range site; orchard group 3.

Supplee very fine sandy loam, 15 to 25 percent slopes (SuD).-This soil is near the edges of and along the dissected drainageways of terraces. Included in mapping were small areas where slopes are less than 15 percent or more than 25 percent.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mainly for orchards and hay. Capability unit IVe-1; not in a woodland suitability group ; Sandy Loam range site; orchard group 4.

Supplee very fine sandy loam, 25 to 45 percent slopes (SuE).-This soil is on terrace breaks and along dissected drainageways. It is similar to Supplee very fine sandy loam, 0 to 3 percent slopes, except that it is slightly shallower to outwash gravel and cobblestones.

Included with this soil in mapping were small areas where slopes are less than 25 percent.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mostly for range and wildlife habitat. Capability unit VIe-1; not in a woodland suitability group; Sandy Loam range site; orchard group 4.

Terrace Escarpments

Terrace escarpments (Te) consists of steep to very steep terrace breaks that are scattered throughout the survey area. Vegetation consists of bunchgrass and scattered brush. A typical area consists of a thin layer of surface soil over glacial outwash of sand, gravel, and cobblestones. These areas are used to a limited degree by wildlife and have value as a source of sand and gravel. They are associated with Pogue, Burch, and Cashmere soils. Capability unit VIIIs-1; not in a woodland suitability group, a range site, or an orchard group.

Thow Series

The Thow series consists of well-drained, medium-textured and moderately coarse textured soils that formed in pumice. Volcanic ash, and deposits of loess over granite, granodiorite, or gneiss bedrock. These soils are on mountainous uplands. Slopes are 0 to 45 percent. Native vegetation is mainly Douglas-fir, ponderosa pine, pinegrass, bitterbrush, and lupine. Elevation ranges from 2,000 to 4,000 feet. The average annual precipitation is 16 to 40 inches, average annual air temperature is 46° to 48° F., and the frost-free season is 75 to 120 days. These soils are associated mainly with Dinkleman, Margrum, and Entiat soils.

In a representative profile the surface layer is gray gravelly fine sandy loam less than 1 inch thick. The subsoil is light brownish-gray, pale-brown, and brown gravelly fine sandy loam and very gravelly sandy loam about 41 inches thick. The substratum is brown very gravelly sandy loam that extends to a depth of 60 inches.

Thow soils are used for woodland and wildlife habitat.

Thow gravelly fine sandy loam, 25 to 45 percent slopes (ThE).-This soil is on mountainous uplands. Slopes average 35 percent.

Representative profile, in an area along logging road, 200 feet north of sharp curve in county road, 1,000 feet west of northeast corner of sec. 14, T. 28 N., R. 22 E., Chelan County

O1-1 inch to 0, undecomposed twigs, needles, and roots.

A2-0 to 1/2 inch, gray (10YR 6/1) gravelly fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, fine, crumb structure ; soft, friable, slightly sticky and slightly plastic ; many fine roots ; few medium tubular pores ; 25 percent pumice of gravel size ; slightly acid ; abrupt, smooth boundary.

B21-1/2 to 10 inches, light brownish-gray (10YR 6/2) gravelly fine sandy loam, dark yellowish brown (10YR 3/3) moist; weak, fine, subangular blocky structure ; soft, friable, slightly sticky and slightly plastic ; many fine roots ; few medium tubular pores ; 30 percent pumice of gravel size; neutral; gradual, wavy boundary.

B22-10 to 30 inches, pale-brown (10YR 6/3) very gravelly sandy loam, dark yellowish brown (10YR 3/4) moist; weak, fine, subangular blocky structure ; soft, friable, nonsticky and nonplastic ; many fine roots; few medium tubular pores ; 50 percent pumice of gravel size; neutral; gradual, wavy boundary.

B3-30 to 52 inches, brown (10YR 5/3) very gravelly sandy loam, dark yellowish brown (10YR 3/4) moist; massive to weak, fine, subangular blocky structure ; soft, friable, nonsticky and nonplastic; common fine roots ; few medium to coarse tubular pores; 60 percent pumice of gravel size; neutral gradual, wavy boundary.

C-42 to 60 inches, brown (10YR 5/3) very gravelly sandy loam, dark brown (10YR 4/3) moist ; massive ; soft, friable, nonsticky and nonplastic; few fine roots ; common medium tubular pores ; 60 percent pumice of gravel size; slightly acid.

The A2 horizon, where present, has a dry value of 5 or 6, a moist value of 3 to 5, and a dry and moist chroma of 1 or 2. The A2 horizon has weak, crumb or granular structure. The B2 horizon is 23 to 48 inches thick. It has a dry value of 5 to 7, a moist value of 3 or 4, a dry chroma of 1 to 4, and a moist chroma of 2 to 4. Structure in this horizon is weak granular, crumb, or blocky. The B3 and C horizons have a hue of 10YR, a dry value of 5 to 7, a moist value of 3 to 5, and a dry and moist cbroma of 2 to 4. The B3 horizon is 10 to 20 inches thick. Texture is fine sandy loam or sandy loam and is very gravelly ; all of the gravel is pumice. The B3 and C horizons are massive or they have weak, blocky structure. Reaction is slightly acid or neutral throughout. In the control section, the soil material is 60 to 90 percent pyroclastics. Content of coarse fragments, which consist of gravel-size pumice, in the soil ranges from 35 to 70 percent, by volume. Depth to granite, schist, or gneiss bedrock ranges from 40 to 72 inches.

Included with this soil in mapping were small areas of Dinkleman and Margerum soils and some areas that are rocky.

Permeability is moderately rapid. Runoff is rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is high. The available moisture capacity is 8 to 9 inches.

This soil is used mainly for woodland and wildlife habitat. Capability unit VIe-1; woodland suitability group 5o2; not in an orchard group or a range site.

Thow gravelly loam, 0 to 25 percent slopes (TgD).-This soil is on mountainous uplands. Included in mapping were small areas where slopes are more than 25 percent and some soils where the surface layer is gravelly fine sandy loam.

Runoff is slow to medium, and the hazard of water erosion is slight to moderate.

This soil is used mainly for woodland and wildlife habitat. Capability unit IVe-1; woodland suitability group 5r2; not in an orchard group or a range site.

Tronsen Series

The Tronsen series consists of well-drained, medium-textured soils that formed in glacial till derived mainly from basalt that has an admixture of loess and volcanic ash. These soils are on uplands. Slopes are 8 to 45 percent. Native vegetation is mainly bluebunch wheatgrass, Idaho fescue, bluegrass, lupine, balsamroot, and few ponderosa pine. Elevation ranges from 1,000 to 2,500 feet. The average annual precipitation is 12 to 16 inches, average annual air temperature is 48° F., and the frost-free season is 140 to 165 days. These soils are associated mainly with Colockum, Cowiche. Loneridge. and Stemilt soils.

In a representative profile the surface layer is dark-gray stony silt loam 8 inches thick. The upper part of the subsoil is brown and pale-brown very gravelly clay loam 40 inches thick. The lower part of the subsoil is light yellowish-brown very gravelly clay that extends to a depth of 60 inches. Basalt bedrock underlies these soils, generally at depths of less than 6 feet.

Tronsen soils are used for range and wildlife habitat.

Tronsen stony silt loam, 25 to 45 percent slopes (TrE).-This soil is on uplands. Slopes average 30 percent.

Representative profile, in an area 1,320 feet east of west quarter corner, along road 1/1 in SW1/4 sec. 34, T. 21 N., R. 21 E., Chelan County:

A1-0 to 8 inches, dark-gray (10YR 4/1) stony silt loam, very dark gray (10YR 3/1) moist; weak, fine, subangular blocky structure ; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores ; 30 percent gravel, cobblestones, and stones; neutral ; clear, smooth boundary.

B21t-8 to 26 inches, brown (10YR 4/3) very gravelly clay loam, dark brown (10YR 3/3) moist; moderate, fine and medium, subangular blocky structure ; very hard, very firm, sticky and plastic ; few fine and medium roots ; many very fine tubular pores ; many moderately thick clay films on ped surfaces ; 60 percent gravel, cobblestones, and stones ; lime coating on lower surface of coarse fragments ; slightly effervescent ; mildly alkaline ; abrupt, wavy boundary.

B22t-26 to 48 inches, pale-brown (10YR 6/3) very gravelly heavy clay loam; dark brown (10YR 4/3) moist; moderate, fine and medium, subangular blocky structure ; very hard, very firm, very sticky and very plastic ; few roots ; many very fine tubular pores ; common thin clay films on ped surfaces and ii: pores ; 70 percent gravel, cobblestones, and stones ; slightly effervescent ; mildly alkaline ; gradual, wavy boundary.

IIB23t-48 to 60 inches, light yellowish-brown (10YR 6/4) very gravelly clay; yellowish brown (10YR 5/4) moist ; massive ; extremely hard, extremely firm ; very sticky and very plastic; many very fine tubular pores ; continuous thin clay films on all ped surfaces ; 75 percent gravel, cobblestones, and stones ; mildly alkaline.

The A horizon ranges from 6 to 10 inches in thickness. It has a hue of 10YR or 7.5YR, a dry value of 4 or 5, a moist value of 2 or 3, and a dry and moist chroma of 1 to 3. This horizon is 20 to 50 percent coarse fragments, and it has a weak or moderate, blocky or granular structure. Depth to secondary carbonates is more than 7 inches. Reaction is slightly acid to mildly alkaline. The B2t horizon is more than 35 inches thick. It has a hue of 10YR or 7.5YR, a dry value of 4 to 6, a moist value of 3 to 5, and a dry and moist chroma of 3 or 4. Texture is clay loam, silty clay loam, or clay that is very gravelly or very cobbly. In this horizon, content of coarse fragments, dominantly of basalt, ranges from 40 to 80 percent and content of clay from 25 to 50 percent. Structure is moderate or strong and blocky or prismatic. Reaction is mildly alkaline to moderately alkaline throughout. The B2t horizon is calcareous. Depth to basalt bedrock is 50 to 72 inches.

Included with this soil in mapping were small areas of Colockum and Stemilt soils and some areas where slopes are more than 45 percent. Also included were small areas of Rock outcrop.

Permeability is moderately slow. Runoff is rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter' and early in spring. The hazard of water erosion is high. The available moisture capacity is 5 to 6 inches.

This soil is used mainly for range and wildlife habitat. Capability unit VIIs-1; Loamy (L-2) or North Expo-

sure (N-1) range site; not in an orchard group or a woodland suitability group.

Tronsen stony silt loam, 8 to 25 percent slopes (TrD).-This soil is on uplands. Included in mapping were small areas where slopes are more than 25 percent.

Runoff is medium, and the hazard of water erosion is moderate.

This soil is used mainly for range and wildlife habitat. Capability unit VIIs-1; Loamy (L-2) range site; not in an orchard group or a woodland suitability group.

Tyee Series

The Tyee series consists of well-drained, coarse-textured soils that formed in decomposing granodiorite, but the surface layer contains varying amounts of loess and volcanic ash. These soils are on uplands. Slopes are 25 to 65 percent. Native vegetation is mainly balsamroot, lupine, bluegrass, bluebunch wheatgrass, bitterbrush, and scattered ponderosa pine. Elevation ranges from 1,600 to 3,500 feet. The average annual precipitation is 9 to 16 inches, average annual air temperature is about 53° F., and the frost-free season is 145 to 165 days. These soils are associated mainly with Entiat and Dinkelman soils. In a representative profile the surface layer is pale-brown gravelly loamy coarse sand and gravelly sandy loam 12 inches thick. Decomposing granodiorite underlies these soils at a depth of 10 to 15 inches.

Tyee soils are used for range and wildlife habitat.

Tyee gravelly loamy coarse sand, 25 to 65 percent slopes (TyF).-This soil is on side slopes on uplands. Slopes average 50 percent.

Representative profile, in an area 1,320 feet south of center of sec. 25, T. 25 N.. R. 20 E., Chelan County:

A11-0 to 2 inches, pale-brown (10YR 6/3) gravelly loamy coarse sand, dark brown (10YR 3/3) moist; massive; friable, nonsticky and nonplastic; many fine tubular pores ; 30 percent gravel ; neutral ; clear, smooth boundary.

A12-2 to 12 inches, pale-brown (10YR 6/3) gravelly sandy loam, dark yellowish brown (10YR 3/4) moist; massive ; soft, friable, nonsticky and nonplastic ; many fine roots ; many fine and medium tubular pores ; 33 percent gravel ; neutral ; abrupt, wavy boundary.

C-12 inches, decomposing granodiorite.

The A11 horizon has a dry value of 5 or 6, a moist value of 3 or 4, and a dry and moist chroma of 2 or 3. Structure is massive to weak, fine, crumb. The A12 horizon has a dry value of 5 or 6 and a dry and moist chroma of 3 or 4. It has a weak, medium, subangular blocky structure, or is massive. A small amount of pumice and ash is in the soil. Depth to bedrock ranges from 10 to 15 inches.

Included with this soil in mapping were small areas of Entiat and Dinkelman soils, some soils that have a surface layer of gravelly sandy loam, and some areas of Rock outcrop.

Permeability is moderately rapid. Runoff is rapid to very rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is high to very high. The available moisture capacity is about 1.5 inches.

This soil is used mainly for range and wildlife habitat. Capability unit VIIe-1; Very Shallow (C) range site; not in an orchard group or a woodland suitability group.

Varelum Series

The Varelum series consists of well-drained, medium-textured soils that formed in weathered sandstone. The surface layer is influenced by loess and a small amount of volcanic ash. These soils are on mountainous uplands. Slopes are 3 to 65 percent. Native vegetation is ponderosa pine and Douglas-fir and an understory of grasses, forbs, and shrubs. Elevation ranges from 1,000 to 2,500 feet. The average annual precipitation is 20 to 35 inches, average annual air temperature is 46° F., and the frost-free season is 160 to 185 days. These soils are associated mainly with Cle Elum, Burch, Nard, and Yaxon soils.

In a representative profile the surface layer is grayish-brown and dark-brown silt loam 12 inches thick. The subsoil is yellowish-brown and pale-brown clay loam 20 inches thick. Disintegrating sandstone is at a depth of about 52 inches.

Varelum soils are used mostly for woodland, range, and wildlife habitat. A small acreage is cleared and in orchards and pasture.

Varelum silt loam, 45 to 65 percent slopes (VaF).-This soil is on side slopes on mountainous uplands. Slopes average 60 percent.

Representative profile, in an area 400 feet south and 600 feet east of west quarter corner of sec. 27, T. 24 N., R. 18 E., Chelan County:

A1-0 to 4 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine and medium roots ; few medium tubular pores ; mildly alkaline ; abrupt, smooth boundary.

A3-4 to 12 inches, dark-brown (10YR 4/3) silt loam, dark grayish brown (10YR 4/2) moist; moderate, fine, granular and subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots ; few medium tubular pores ; neutral ; abrupt, smooth boundary.

B2t-12 to 24 inches, yellowish-brown (10YR 5/4) clay loam, dark brown (10YR 4/3) moist; moderate, medium, subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic ; common fine roots ; few fine tubular pores ; few thin clay films on ped surfaces; neutral; abrupt, wavy boundary.

B3t-24 to 52 inches, pale-brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; weak, medium, subangular blocky structure ; hard, very firm, sticky and plastic ; few fine roots ; few fine tubular pores ; few thin clay films on ped surfaces ; neutral ; abrupt, wavy boundary.

R-52 inches, disintegrating sandstone ; few roots.

The A horizon ranges from 9 to 16 inches in thickness. Structure of the A horizon is weak and moderate, fine, granular blocky. The A1 horizon has a dry value of 4 or 5, a moist value of 3 or 4, a dry chroma of 2 or 3, and a moist chroma of 2. The B2t horizon is 10 to 14 inches thick. It has a value of 4 to 6 dry and chroma of 3 or 4. Texture is clay loam or sandy clay loam. Structure ranges from moderate to strong, medium subangular blocky and blocky. The B3t horizon is 24 to 30 inches thick. Depth to disintegrating sandstone ranges from 43 to 60 inches. Reaction is neutral to mildly alkaline throughout.

Included with this soil in mapping were small areas of Cle Elum and Yaxon soils.

Permeability is slow. Runoff is very rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard

of water erosion is very high. The available moisture capacity is 9 to 10 inches.

This soil is used mainly for woodland and wildlife habitat. Capability unit VIIe-1; woodland suitability group 4r1; not in an orchard group or a range site.

Varelum silt loam, 3 to 15 percent slopes (VaC).-This soil is on uplands and toe slopes.

Included in mapping were small areas where slopes are less than 3 percent or more than 15 percent, some areas of soils that are shallower than this soil, and some soils that have a surface layer of fine sandy loam.

Runoff is slow to medium, and the hazard of water erosion is slight to moderate. If this soil is irrigated, runoff is medium to rapid and the hazard of erosion is moderate to high.

This soil is used mostly for woodland. Some of the acreage is cleared and is in orchards or pasture. Capability unit IIIe-1; woodland suitability group 4ol; not in a range site, orchard group 1.

Varelum silt loam, 15 to 25 percent slopes (VaD).-This soil is on uplands. Included in mapping were small areas where slopes are less than 15 percent, or more than 25 percent, some small areas of soils that are shallower than this soil, and some soils that have a surface layer of fine sandy loam.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mostly for woodland. Some of the acreage is cleared and is in orchards or in pasture. Capability unit IVe-1 ; woodland suitability group 4ol ; not in a range site; orchard group 2.

Varelum silt loam, 25 to 45 percent slopes (VaE).-This soil is on uplands.

Included in mapping were small areas where slopes are less than 25 percent or more than 45 percent, some small areas of soils that are shallower than this soil, and some soils that have a surface layer of fine sandy loam.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mostly for woodland. A small acreage is cleared and is in orchards or in pasture. Capability unit VIe-1; woodland suitability group 4r1; not in a range site; orchard group 2.

Wenatchee Series

The Wenatchee series consists of well-drained, medium-textured soils that formed in old alluvium or in valley fill, mainly from sandstone, granite. gneiss. and schist. These soils are on terraces. Slopes are 0 to 8 percent. Where these soils are not, cultivated, vegetation is mainly bluebunch wheatgrass. bluegrass, and big sagebrush. Elevation ranges from 700 to 1,500 feet. The average annual precipitation is 8 to 14 inches, average annual air temperature is 48° to 50° F. and the frost-free season is 170 to 185 days. These soils are associated mainly with Burch, Cowiche, and Varelum soils.

In a representative profile the surface layer is grayish-brown silt loam 8 inches thick. The subsoil is light brownish-gray silt, loam. brown clay loam. and grayish-brown sandy clay loam 43 inches thick. The substratum is light grayish-brown coarse sand that extends to a depth of 60 inches.

Wenatchee soils are used mainly for orchards. Some of the acreage is used for hay and pasture.

Wenatchee silt loam, 0 to 3 percent slopes (WeA).-This soil is on terraces. Slopes average 2 percent.

Representative profile, in an area on south side of highway, 100 feet southeast of small farm approach leading into apple orchard, SW1/4SW1/4 sec. 8, T. 24 N., R. 18 E., Chelan County:

Ap-0 to 8 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; few fine tubular pores ; mildly alkaline ; abrupt, smooth boundary.

B1-8 to 17 inches, light brownish-gray (10YR 6/2) silt loam; dark grayish brown (10YR 4/2) moist; weak, fine, prismatic structure ; slightly hard, friable, slightly sticky and slightly plastic ; many fine roots ; few fine tubular pores ; mildly alkaline ; abrupt, smooth boundary.

B2t-17 to 38 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist ; moderate, coarse, prismatic structure breaking to strong, very fine, angular blocky structure; very hard, very firm, sticky and plastic ; few fine roots : many fine to medium tubular pores ; heavy organic staining and common very thin and thin clay bridges between sand grains and few thin clay films in pores ; mildly alkaline ; abrupt, smooth boundary.

B3t-38 to 51 inches, grayish-brown (2.5Y 5/2) sandy clay loam, dark grayish brown (2.5Y 4/4) moist; weak, medium, prismatic structure ; very hard, very firm, sticky and plastic: few fine roots ; many fine tubular pores ; few fine clay films in pores and few clay bridges between sand grains : mildly alkaline ; clear, smooth boundary.

IIC-51 to 60 inches, light grayish-brown (2.5Y 6/2) coarse sand, dark grayish brown (2.5Y 4/2) moist; single grain.

The Ap horizon ranges from 6 to 10 inches in thickness. It has a hue of 10YR or 2.5Y, a value of 4 or 5, and a chroma of 2 or 3. Structure is weak to moderate, granular. The B1 horizon is 6 to 12 inches thick. The B2 horizon is 12 to 25 inches thick. It has a hue of 10YR or 2.5Y, a value of 5 to 7, and a chroma of 2 to 4. Texture is clay loam or sandy clay loam, and structure is weak, prismatic and moderate to strong, blocky. The B3t horizon is 10 to 16 inches thick. Depth to sand and gravel ranges from 4 to 8 feet. Reaction is neutral or mildly alkaline throughout.

Included with this soil in mapping were small areas of Burch soils and some areas where the surface layer or the substratum is clay loam.

Permeability is slow. Runoff' is very slow. Most runoff occurs during severe thunderstorms or when snow melts rapidly in winter and early in spring. The hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight. The available moisture capacity is 10 to 12 inches.

This soil is used mainly for orchards. It is also used for hay, pasture, and wildlife habitat. Capability unit IIIe-1; not in a woodland suitability group; Loamy (L-2) venue site; orchard group 1.

Wenatchee silt loam, 3 to 8 percent slopes (WeB).-This soil is on terraces. Included in mapping were small areas where slopes are less than 3 percent or more than 8 percent and some areas of soils that have a surface laver or a substratum of clay loam.

Runoff is slow, and the hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate. The available moisture capacity is about 10 inches.

This soil is used mainly for orchards. Capability unit IIIe-1; not, in a woodland suitability group ; Loamy (L-2) range site; orchard group 1.

Wintoner Series

The Wintoner series consists of well-drained, medium-textured soils that formed in old alluvium but have a. small amount of loess and volcanic ash in the surface layer. These soils are on valley bottoms and foot slopes on mountainous uplands near the communities of Plain and Winton. Slopes are 0 to 15 percent. Native vegetation is mainly Douglas-fir, ponderosa pine, white fir, vineleaf maple, willow, snowberry, Oregon grape, rose, elderberry, thimbleberry, and bluegrass. Elevation ranges from 1,900 to 2,300 feet. The average annual precipitation is 20 to 30 inches, average annual air temperature is about 43° F., and the frost-free season is 75 to 120 days. These soils are associated mainly with Leavenworth, Brief, Nard, and Peoh soils. In a representative profile the surface layer is grayish-brown silt loam 3 inches thick. The substratum is pale-brown silt loam to a depth of 60 inches. Wintoner soils are used mostly for woodland and wildlife habitat, but a small acreage is in berries, vegetable crops, hay, and pasture.

Wintoner silt loam, 8 to 15 percent slopes (WnC).-This soil is on valley foot slopes. Slopes average 9 percent.

Representative profile, in an area 1,000 feet north and 150 feet east of west quarter corner of sec. 21, T. 26 N., R. 17 E., Chelan County:

O1&O2-1 inch to 0, undecomposed and slightly decomposed needles, twigs, and leaves.

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

B21t-3 to 10 inches, pale-brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; weak, fine and medium, prismatic structure that parts to moderate, fine and medium. subangular blocky structure ; hard, firm, sticky and plastic; few fine roots ; very few very fine tubular pores ; few thin clay bridges between sand grains and few thin clay films on ped surfaces; neutral; gradual, wavy boundary.

B22t-10 to 28 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate, fine, prismatic structure that parts to moderate, fine and medium, subangular blocky structure; hard, very firm, sticky and plastic ; few fine roots ; very few very fine tubular pores ; few thin clay films in pores, few thin clay bridges between sand grains, and few thin clay films on ped surfaces ; neutral ; gradual, wavy boundary.

B3t-28 to 38 inches, pale-brown (10YR 6/3) sandy clay loam, dark brown (10YR 4/3) moist; massive ; hard, firm, sticky and plastic; few fine roots; very few very fine tubular pores: common thin clay bridges between sand grains and very few moderately thick clay films in pores and on ped surfaces ; slightly acid; gradual, wavy boundary.

C-38 to 60 inches. pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist ; massive ; slightly hard, firm, slightly sticky and slightly plastic ; few fine roots ; very few very fine tubular pores ; slightly acid.

The A horizon ranges from 2 to 4 inches in thickness. It has a dry value of 5 or 6, a moist value of 3 or 4, and a dry and moist chroma of 2 or 3. Structure is moderate, granular or blocky. The B2t horizon is 22 to 28 inches thick. It has a dry value of 5 or 6, a moist value of 4, and a dry or moist chroma of 3 or 4. Texture is clay loam or sandy clay loam, and structure is weak or moderate, prismatic and blocky. The B3t horizon is 8 to 12 inches thick. The C horizon has the same range of color as the B horizon, and texture is silt loam, clay loam, or sandy clay loam. Reaction is neutral or slightly acid throughout.

Included with this soil in mapping were small areas of Nard and Brief soils. Also included were small areas where slopes are less than 8 percent.

Permeability is slow. Runoff is very slow to medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is slight to moderate. If this soil is irrigated, runoff is rapid and the hazard of erosion is high. The available moisture capacity is 10 to 12 inches.

This soil is used mainly for woodland and wildlife habitat, but a small acreage is in berries, vegetable crops, hay, and pasture. Capability unit IVe-l; woodland suitability group 3o3; not in an orchard group or a range site.

Wintoner silt loam, 0 to 3 percent slopes (WnA).-This soil is on bottom lands in valleys. Included in mapping were small areas where slopes are more than 3 percent and some areas of Peoh and Brief soils.

Runoff is very slow. and the hazard of water erosion is none to slight. If this soil is irrigated, runoff is slow and the hazard of erosion is slight.

This soil is used mainly for woodland and wildlife habitat. Capability unit IVe-1; woodland suitability group 3o3; not in an orchard group or a range site.

Wintoner silt loam, 3 to 8 percent slopes (WnB).-This soil is on foot slopes in valleys. Included in mapping were small areas where slopes are less than 3 percent or more than 8 percent and some areas of Brief soils. Runoff is slow, and the hazard of water erosion is slight. If this soil is irrigated, runoff is medium and the hazard of erosion is moderate.

This soil is used mainly for woodland and wildlife habitat. Capability unit IVe-1; woodland suitability group 3o3; not in an orchard group or a range site.

Yaxon Series

The Yaxon series consists of well-drained, medium-textured soils that formed mainly in weathered residual sandstone and loess. The soils have a small amount of volcanic ash in the surface layer. These soils are mostly in areas that face north or west on uplands. Slopes are 8 to 65 percent. Where these soils are not cultivated, vegetation is mainly bluebunch wheatgrass, bluegrass, Idaho fescue, and scattered ponderosa pine. Elevation ranges from 1,000 to 3,000 feet. The average annual precipitation is 12 to 15 inches, average annual air temperature

is about 50° F., and the frost-free season is 160 to 175 days. These soils are associated with Cowiche, Varelum, and Cle Elum soils.

In a representative profile the surface layer is dark grayish-brown and grayish-brown silt loam 20 inches thick. The subsoil is brown clay loam 30 inches thick. The substratum is yellowish-brown sandy clay loam that extends to a depth of 60 inches.

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

Yaxon silt loam, 25 to 45 percent slopes (YaE).-This soil is on hilly uplands. Slopes average 30 percent.

Representative profile, in an area 1,400 feet north and 800 feet east of southwest corner of sec. 25, T. 23 N., R. 19 E., Chelan County:

Ap-0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular and subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots ; few fine tubular pores ; mildly alkaline ; clear, wavy boundary.

A1-8 to 20 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, subangular blocky structure ; hard, friable, slightly sticky and slightly plastic; common fine roots ; few fine pores ; mildly alkaline; clear, wavy boundary.

B21-20 to 30 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; strong fine subangular blocky structure ; very hard, friable, very sticky and very plastic; few fine fibrous roots ; common fine tubular pores very few hard nodules; mildly alkaline; gradual, wavy boundary.

B22-30 to 50 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate, medium, subangular blocky structure ; hard, friable, sticky and plastic; few fine fibrous roots ; many fine tubular pores ; very few hard nodules ; few grainy coatings on ped surfaces; mildly alkaline: gradual, wavy boundary.

C-50 to 60 inches. yellowish-brown (10YR 5/4) sandy clay loam, dark brown (10YR 3/4) moist; massive; hard, friable, sticky and plastic ; few fine roots: many fine pores ; mildly alkaline.

The A horizon ranges from 14 to 24 inches in thickness. The A1 horizon has a dry value of 4 or 5. a moist value of 2 or 3. and a dry and moist chroma of 2 or 3. Its structure is weak or moderate. The B2 horizon is 16 to 24 inches thick. It has a dry value of 5, a moist value of 3 or 4, and a dry and moist chroma of 3 or 4. Texture is clay loam or sandy clay loam, and structure is moderate or strong, blocky. The C horizon has the same range in color and texture as the B horizon. Depth to sandstone bedrock ranges from 40 inches to more than 60 inches. Reaction is neutral or mildly alkaline throughout.

Included with this soil in mapping were small areas of Cowiche and Varelum soils.

Permeability is slow. Runoff is rapid. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is high. The available moisture capacity is 10 to 12 inches.

This soil is used mainly for dryfarmed wheat and barley. It is also used for range and wildlife habitat. Capability unit IVe-1; Loamy (L-2) or North Exposure (N-1) range site: not in an orchard group or a woodland suitability group.

Yaxon silt loam, **8 to 25 percent slopes** (YaD).-This soil is on uplands. Included in mapping were small areas where slopes are more than 25 percent.

Runoff is medium, and the hazard of water erosion is moderate.

This soil is used mainly for dryfarmed wheat and barley. Capability unit IIIe-1; Loamy (L-2) range site; not in an orchard group or a woodland suitability group.

Yaxon silt loam, 45 to 65 percent slopes (YaF).-This soil is on uplands. Included in mapping, were small areas where slopes are less than 45 percent.

Runoff is very rapid, and the hazard of water erosion is very high.

This soil is used for range and wildlife habitat. Capability unit VIIe-1; Shallow (S-2) or North Exposure (N-1) range site; not in an orchard group or a woodland suitability group.

Zen Series

The Zen series consists of well-drained, medium-textured soils that formed in wind-laid silt mixed with small amounts of volcanic ash over basalt bedrock. These soils are on uplands. Slopes are 0 to 45 percent. Where these soils are not cultivated, vegetation is mainly bluebunch wheatgrass. Idaho fescue, bluegrass, and sage-brush. Elevation ranges from 1,000 to 2,800 feet. The average annual precipitation is 8 to 12 inches, average annual air temperature is about 50° F., and the frost-free season is 160 to 175 days. These soils are associated mainly with Ritzville, Cowiche, and Colockum soils.

In a representative profile the surface layer is grayish-brown and brown silt loam 18 inches thick. The subsoil is yellowish-brown heavy silt loam 6 inches thick. Basalt bedrock underlies these soils at a depth of 24 inches.

Zen soils are used for dryfarmed cereal grain, hay, orchards. range. and wildlife habitat.

Zen silt loam, 8 to 15, percent slopes (ZeC).-This soil is on broad uplands. Slopes average 12 percent. Representative profile, in an area 1,000 feet southeast of center of sec. 13, T. 21 N., R. 21 E., Chelan County:

Ap-0 to 7 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium. platy structure ; slightly hard, very friable, nonsticky and nonplastic ; many fine roots ; few fine pores ; neutral ; clear, smooth boundary.

A1-7 to 18 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; weak, fine, granular structure; slightly hard, friable, nonsticky and slightly plastic ; common fine roots ; common fine pores ; neutral ; clear, smooth boundary.

B2-18 to 24 inches. yellowish-brown (10YR 5/4) heavy silt loam, dark brown (10YR 4/3) moist; moderate, medium, subangular blocky structure ; slightly hard, friable, nonsticky and slightly plastic ; few fine roots ; many fine tubular pores ; neutral ; abrupt, wavy boundary.

IIR-24 inches, basalt bedrock.

The Ap horizon ranges from 5 to 8 inches in thickness. It has a dry value of 4 or 5, a moist value of 2 or 3, and a dry chroma of 2. The content of clay ranges from 15 to 18 percent in the Ap horizon. The A1 horizon is 10 to 12 inches thick. It has a dry value of 4 or 5, a moist value of 2 or 3, and a dry chroma of 3. It has weak. fine, granular structure or weak, medium. subangular blocky structure. In the Al and B2 horizons. the content of clay ranges from 18 to 25 percent. The B2 horizon is 5 to 16 inches thick. It has a dry value of 5 or 6, a moist value of 3 or 4, and a dry chroma of 3 and 4. A few basalt fragments 1/16 to 1/2 inch in diameter are in the lower part of the B2 horizon in places. Texture is dominantly heavy silt loam throughout.

Reaction is neutral or slightly acid throughout. Depth to basalt bedrock ranges from 20 to 36 inches.

Included with this soil in mapping were small areas of Ritzville soils and some areas where slopes are less than 8 percent or more than 15 percent.

Permeability is moderate. Runoff is medium. Most runoff occurs during severe thunderstorms and when snow melts rapidly in winter and early in spring. The hazard of water erosion is moderate.- If this soil is irrigated, runoff is rapid and the hazard of erosion is high. The available moisture capacity is about 4 to 5 inches.

This soil is used mainly for dryfarmed wheat and barley. Other uses are for hay, range, orchards, and wildlife habitat. Capability unit IIIe-1; not in a woodland suitability group; Shallow (S-2) range site; orchard group 3.

Zen silt loam, 15 to 25 percent slopes (ZeD).-This soil is on side slopes on uplands. Included in mapping were small areas where slopes are less than 15 percent or more than 25 percent. Also included were small areas of Ritzville soils.

Runoff is medium, and the hazard of water erosion is moderate. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used mainly for dryfarmed wheat and barley. Capability unit IVe-1; not in a woodland suitability group; Shallow (S-2) range site; orchard group 4.

Zen silt loam, 25 to 45 percent slopes (ZeE).-This soil is on side slopes on uplands. It is similar to Zen silt loam, 8 to 15 percent slopes, except that it is slightly shallower to bedrock.

Included with this soil in mapping were small areas where slopes are less than 25 percent and a few small areas of Ritzville soils. Also included were small areas of Rock land.

Runoff is rapid, and the hazard of water erosion is high. If this soil is irrigated, runoff is very rapid and the hazard of erosion is very high.

This soil is used for dryfarmed wheat and barley and for range. Capability unit VIe-1; not in a woodland suitability group; Shallow (S-2) or North Exposure (N-1) range site ; orchard group 4.

Zen-Rock outcrop complex, 0 to 25 percent slopes (ZrD).-This complex is on uplands. It consists of about 90 percent Zen silt loam, 0 to 25 percent slopes, and about 10 percent Rock outcrop.

Included with this complex in mapping were small strips of talus stones and small areas of soils that are shallower than these soils.

Runoff is slow to medium, and the hazard of water erosion is slight to moderate.

This complex is used for pasture, range, and wildlife habitat. Capability unit VIIs-1; Loamy (L-2) range site; not in an orchard group or a woodland suitability group.

Zen-Rock outcrop complex, 25 to 45 percent slopes (ZrE).-This complex is on uplands. It consists of about 90 percent Zen silt loam, 25 to 45 percent slopes, and about 10 percent Rock outcrop.

Included with this complex in mapping were small strips of talus stones and small areas of soils that are shallower than these soils.

Runoff is rapid, and the hazard of water erosion is high.

These soils are used for range and wildlife habitat. Capability unit VIIs-1; Shallow (S-2) or Very Shallow range site; not in an orchard group or a woodland suitability group.

Use and Management of the Soils

This section has seven parts. In the first part, the capability classification used by the Soil Conservation Service is described and the soils in Chelan Area are grouped into capability units. Management for the main dryfarmed crops grown in the Area-wheat, grasses, and legumes-is discussed for each capability unit made up of soils suited to them. In the second part, the soils used for tree fruits are placed into orchard groups and the principal management needs of each group are given. In the third part, yields of the principal crops grown in the Area are given for the soils on which the specified crops are grown. In the fourth part, range management is discussed and the soils used for grazing are placed into range sites. The fifth part consists of a discussion of woodland, and the soils used for woodland are placed into woodland suitability groups. In the sixth part is a discussion of the use of soils for wildlife. The last part of this section consists of a discussion of engineering uses of the soils.

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 requiring special management.

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

In the capability system, the kinds of soils are grouped at three levels: the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use. (None in Chelan Area)

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices. (None in Chelan Area)

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 pastuure, range, woodland, or wildlife habitat. (None in Chelan Area)

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

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

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

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e, w, s, or c* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage; *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in Chelan Area but not in all parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. 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, 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 a 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, IIIe-1 or VIIs-1. 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 paragraphs; and the Arabic numeral specifically identifies the capability unit within each subclass.

Management by capability units

In the following pages the capability units represented in the Chelan Area are described, and suggestions are given for the use and management of the soils.

The use and management of soils that. are not irrigated in the Chelan Area are governed mainly by climate. For a given crop many of the same tillage practices are used throughout the Area, but intensity and timing vary from one section to another. The principal crops grown without irrigation are wheat, rye, and barley, grown in a crop-fallow system, and grasses and legumes for hay and pasture.

The soil series represented in a capability unit are named in the description of the capability unit, but this does not mean that all of the soils of a given series appear in the unit. To find the names of all of the soils in any (riven capability unit, refer to the " Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT IIIe-1

This unit consists mainly of well-drained soils of the Burch, Cashmere. Chelan, Colockum. Cowiche, Ellisforde. Margerum, and Ritzville series. Slopes are 0 to 25 percent. Also in this unit, because their total acreage is small or they are inaccessible and not used for the common crops, are soils of the Antilon, Bjork, Leavenworth, Peshastin, Varelum, Wenatchee, Yaxon, and Zen series. The soils in this unit hold 7 to 12 inches of water that plants can use. Permeability ranges from moderately slow to moderately rapid. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Average annual precipitation is 8 to 16 inches. The frost-free season is 140 to 200 days.

These soils are suited to small grain in a summerfallow system and to grasses and legumes for hay and pasture. Precipitation is too low for annual cropping of grain.

Wheat is the principal grain crop. It can be grown without excessive erosion if fertilizer is applied, if stubble-mulch tillage is used, and if the soils are tilled no more than necessary to control weeds and to prepare a seedbed.

If grasses and legumes are grown, best results are obtained by using fertilizer, controlling rodents and weeds, and reseeding about every 5 years. Rotation grazing and deferred grazing are desirable if areas are used for pasture. Grain and grasses respond to nitrogen and, in places, to sulfur. Legumes respond to phosphorus and sulfur, and in places to boron.

Farming across the slope is advisable in most places. Where slopes are long, diversion terraces, field terraces, stripcropping, and grassed waterways are also needed. Where steeper soils are upslope, systems of field terraces or diversion terraces are needed in places to intercept runoff. In places chiseling and subsoiling are needed every few years to break tillage pans. Growing grasses and legumes in the, rotation helps to maintain or improve tilth and also aids in the control of further erosion.

CAPABILITY UNIT IIIw-1

This unit consists only of Alluvial land. This soil is moderately well drained. Slopes range from 0 to 3 percent. In places there is a temporary seasonal water table in spring because of the low position of this land type. Alluvial land holds about 7 inches of water that plants can use. Permeability is moderately rapid. Runoff ranges from ponded to very slow, and the hazard of water erosion is none to slight. About 1 year in 5, this land type is subject to overflow from nearby streams. Average annual precipitation is 7 to 30 inches, and the frost-free season is 100 to 190 days.

This land type is used mainly for pasture and hay. It could be used for growing small grain, but is not likely to be used for this purpose, because the total acreage is small, and the individual areas are scattered. If grain is grown, management needs include applying fertilizer, using stubble-mulch tillage, and tilling the soil no more than necessary to control weeds and to prepare a seedbed. Grain and grasses respond to nitrogen and, in places, to sulfur. Legumes respond to phosphorus, sulfur, and boron.

Alfalfa, clover, and grasses can be grown for both hay and pasture. Best results are obtained by using fertilizer, controlling weeds and rodents, and reseeding about every 5 years. Rotation grazing and deferred grazing are desirable practices if the areas are used for pasture.

CAPABILITY UNIT IIIw-2

Only Peoh silt loam is in this unit. Slopes range from 0 to 3 percent. This soil is poorly drained. It holds about 10 to 12 inches of water that plants can use. Permeability is slow. Runoff is ponded to very slow. and the hazard of water erosion is slight or none. The average annual precipitation is 15 to 25 inches, and the frost-free season is 130 to 165 days.

This soil is used mainly for pasture. A few areas have been drained. Clover and grass is a suitable pasture mixture. This soil is not suited to alfalfa. This soil is difficult to drain and is not suited to tree fruits, even after drainage. Small grain could be grown, but the soil is not likely to be used for this purpose, because the total acreage is small, and the areas are scattered. If grain is grown, management needs include applying fertilizer, using stubble mulch tillage, and tilling the soil no more than is necessary to control weeds and to prepare a seedbed. Grain and grasses respond to nitrogen and, in places, to sulfur. Legumes respond to phosphorus, sulfur, and boron.

If this soil is used for pasture, suitable management practices are deferring grazing until after the soil. dries in spring, using rotation grazing, applying fertilizer, controlling weeds and rodents, and reseeding about every 5 years.

The soil is not generally used for hay, because equipment bogs down and tends to pack the soil.

CAPABILITY UNIT IIIc-1

This unit consists of well-drained soils of the Burch series. Slopes range from 0 to 3 percent. These soils hold about 10 to 12 inches of water that plants can use. Permeability is moderate. Runoff is very slow, and the hazard of water erosion is slight to none. The average annual precipitation is 8 to 15 inches, and the frost-free season is 165 to 190 days.

These soils are used mainly for growing grasses -and legumes for hay and pasture. They could be used for small grain but are not likely to be used for this purpose, because individual areas not in grasses, legumes, or tree fruits are small and scattered and the total acreage is small. If grain is grown, suitable management practices include application of fertilizer, use of stubble-mulch tillage, and tilling no more than necessary to control weeds and to prepare a seedbed.

If these soils are used for hay, management needs include applying fertilizer, controlling weeds and rodents, and reseeding about every 5 years. Rotation and deferred grazing are desirable if areas are used for pasture.

CAPABILITY UNIT IVe-1

This unit consists mainly of well-drained and somewhat excessively drained soils of the Brief, Burch, Cashmere, Cashmont, Chelan, Colockum, Cowiche, Margerum, Pogue, Ritzville, and Supplee series. Slopes are 0 to 45 percent. Also in this unit, because their total acreage is small or they are inaccessible and not used for the commonly grown crops, are soils of the Antilon, Bjork, Chiwawa, Dinkelman, Goddard, Leavenworth, Nard, Stemilt, Thow, Varelum, Wintoner, Yaxon, and Zen series. The soils in this unit hold 5 to 12 inches of water that plants can use. Permeability ranges from moderately slow to very rapid. Runoff is slow to rapid, and the hazard of erosion is slight to high. Average annual precipitation is 8 to 25 inches. The frost-free season is 140 to 200 days.

These soils are suited to small grain in a summer-fallow system and to grasses and legumes for hay and pasture. Precipitation is generally too low for annual cropping of grain.

Wheat is the principal grain crop. It can be grown without excessive erosion if fertilizer is applied, if stubble-mulch tillage is used, and if the soils are tilled no more than necessary to control weeds and to prepare a seedbed. If grasses and legumes are grown, best results are obtained by using fertilizer, controlling rodents and weeds, and reseeding about every 5 years. Rotation grazing and deferred grazing are desirable if the areas are used for pasture. Grain and grasses respond to nitrogen and, in places, to sulfur. Legumes respond to phosphorus and sulfur and, in places, to boron.

Farming across the slope is advisable in most places. Where slopes are long, diversion terraces, field terraces, stripcropping, and grassed waterways are also needed. Where steeper soils are upslope, systems of field terraces or diversion terraces are needed to intercept runoff. In places, such practices as chiseling and subsoiling are needed every few years to break tillage pans. Growing grasses find legumes in the rotation helps to maintain or improve tilth and aids in the control of further erosion.

CAPABILITY UNIT VIe-1

This unit consists of somewhat excessively drained to moderately well drained soils of the Antilon, Beverly, Bjork, Cashmont, Chelan, Cle Elum, Colockum, Cowiche, Dinkelman, Entiat, Loneridge, Malaga, Nard, Nevine, Peshastin, Pogue, Stemilt, Supplee, Thow, Varelum, and Zen series and the Jumpe series, thick surface variant. Slopes are 0 to 60 percent. These soils hold 3 to 12 inches of water that plants can use. Permeability ranges from slow to very rapid. Runoff ranges from very slow to very rapid, and the hazard of erosion ranges from none to very high. Average annual precipitation is 8 to 40 inches. The frost-free period is 75 to 200 days.

These soils are better suited to grazing or to trees than to most other uses.

CAPABILITY UNIT VIs-1

This unit consists of soils of the Anatone and Pogue series. The Pogue soil is somewhat excessively drained, and

the Anatone soil is well drained. Slopes are 0 to 45 percent. These soils hold 1.5 to 5 inches of water that plants can use. Permeability is moderate to very rapid. Runoff ranges from very slow to rapid, and the hazard of erosion from slight to high. Average annual precipitation is 8 to 30 inches, and the frost-free period is 110 to 190 days.

These soils are better suited to grazing than to most other uses.

CAPABILITY UNIT VIIe-1

This unit consists of well-drained to somewhat excessively drained soils of the Ardenvoir, Beverly, Bjork, Cle Elum. Cowiche. Entiat. Morical. Nard, Quincy, Tyee, Varelum, and Yaxon series. Slopes are 0 to 65 percent. These soils hold 1.5 to 12 inches of water that plants can use. Permeability ranges from slow to rapid. Runoff ranges from very slow to very rapid, and the hazard of erosion from none to very high. Average annual precipitation is 7 to 35 inches, and the frost-free period is 75 to 200 days.

These soils are better suited to grazing or to trees than to most other uses.

CAPABILITY UNIT VIIs-1

This unit consists of areas of Rock land and of well-drained soils of the Cle Elum, Dinkelman, Jumpe, Loneridge, Nard, Tronsen, and Zen series and the Jumpe series, red variant. Slopes are 0 to 65 percent. These soils hold 4 to 12 inches of water that plants can use. Permeability ranges from slow to moderately rapid. Runoff ranges from slow to very rapid, and the hazard of erosion from slight to very high. Average annual precipitation is 8 to 35 inches, and the frost-free period is 75 to 185 days.

These soils are better suited to grazing or to trees than to most other uses.

CAPABILITY UNIT VIIIs-1

This unit consists of areas of Riverwash, Rock outcrop, and Terrace escarpments. Riverwash and Rock outcrop are essentially bare of vegetation. Terrace escarpments have a thin surface layer underlain by sand, gravel, and cobblestones and support bunchgrass and scattered brush.

These land types are better suited to wildlife habitat than to most other uses.

Orchard Groups

About 27,000 acres in the Chelan Area is used for irrigated orchard crops. Suitable orchard crops are apples, pears, peaches, apricots, and cherries.

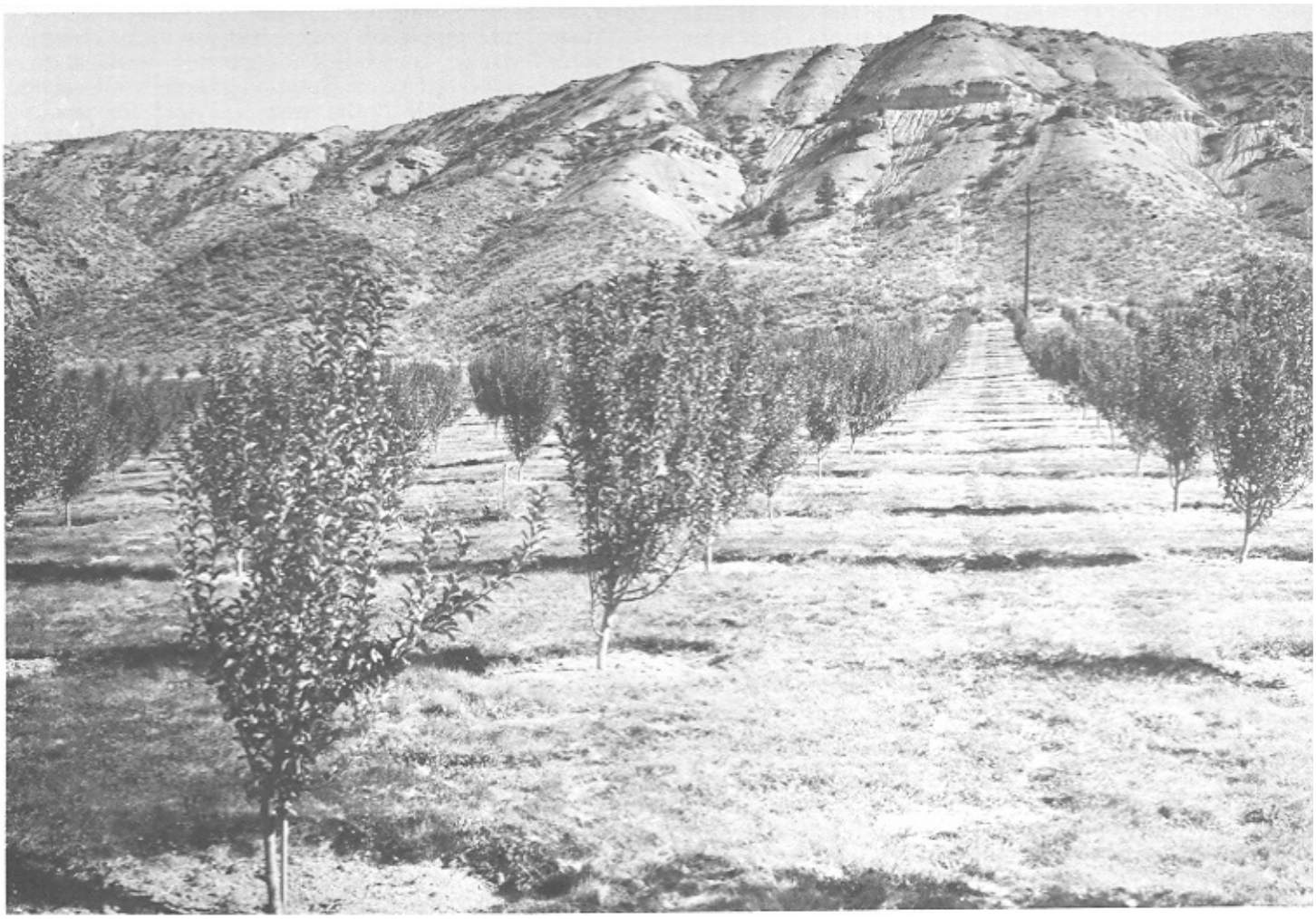

Figure 11.-Excellent cover crop of creeping red fescue in young apple orchard on Burch loam, 0 to 3 percent slopes (Orchard group 1).

The soils in the Area that are used for orchard crops have been placed into five orchard groups. The soils in each group require about the same kind of management.

The soils in each orchard group need annual applications of nitrogen. Zinc and boron should be sprayed on the foliage of apple trees every other year. The most desirable pH for soils used for tree fruits is 5.5 to 6.5. Lime should be added to the soil if the pH is less than about 5.0. and ammonium sulfate or ferrous ammonium sulfate should be added if the pH is more than about 7.5.

Chiseling and subsoiling should be accomplished periodically. Rotobeating or mowing are suitable practices for leaving crop residue on the surface. Land smoothing is needed in places. Rodents and insects should be controlled according to recommendations of State and local authorities. The soils should be tested to determine their arsenic content. Arsenic-free soil is needed until the roots of young trees are established. Before replanting in old orchards, where arsenic toxicity is likely, the soil should be excavated from the planting site and replaced with fresh soil.

Following is a brief description of the soils in each orchard group and the major needs of management. For the names of the soils in each group, see the "Guide to Mapping Units" at the back of this survey.

Orchard group 1.-The soils in this group are deep or very deep. Slopes are 0 to 15 percent.

Suitable perennial cover crops on these soils are orchardgrass and creeping red fescue (fig. 11). Volunteer grasses are generally a suitable annual cover crop.

Sprinkler irrigation is suitable on all of the soils, and surface irrigation is suitable where slopes are 0 to 5 percent. During the growing season, 3 to 5 inches of water should be applied every 2 to 3 weeks at a rate of 0.25 inch per hour.

Orchard group 2.-The soils in this group are deep or very deep. Slopes are 15 to 45 percent.

Suitable perennial cover crops on these soils are orchardgrass and creeping red fescue. Annual cover crops are not recommended.

Only sprinkler irrigation is recommended. During the growing season. 3 to 5 inches of water should be applied every 2 to 3 weeks at a rate of 0.20 inch per hour.

Orchard group 3.-The soils in this group are moderately deep over gravel. bedrock, or slowly permeable layers. Slopes are 0 to 15 percent.

Suitable perennial cover crops on these soils are orchardgrass and creeping red fescue. Volunteer grasses are generally a suitable annual cover crop.

Sprinkler irrigation is suitable on all of the soils. Surface irrigation is suitable where slopes or 0 to 5 percent. During the growing season, 2 to 4 inches of water should be applied every 5 days to 2 weeks at a rate of 0.25 inch per hour.

Orchard group 4.-The soils in this group are shallow to or moderately deep over bedrock, gravel, sand, or slowly permeable layers. Slopes are 15 to 45 percent.

Suitable perennial cover crops on these soils are orchardgrass and creeping red fescue. Annual cover crops are not recommended.

Only sprinkler irrigation is suitable. During the growing season, 2 to 4 inches of water should be applied every 5 days to 2 weeks at a rate of 0.20 inch per hour.

Orchard group 5.-The soils in this group are moderately deep to very deep over sand, gravel, or bedrock. Coarse fragments are on the surface and throughout the soil. These soils have slopes of 0 to 45 percent.

Suitable perennial cover crops on these soils are orchardgrass and creeping red fescue. Volunteer grasses are a suitable annual cover crop where slopes are 0 to 15 percent.

Sprinkler irrigation is suitable on all of the soils. Surface irrigation is suitable where slopes are 0 to 5 percent. During the growing season. 2 to 4 inches of water should be applied every 5 days to 2 weeks at a rate of 0.20 to 0.25 inch per hour.

Estimated Yields

In this section the estimates of yields of the principal crops grown in the Chelan Area are based on observations of soil scientists who surveyed the Area, on information furnished by farmers, and on information supplied by State and Federal advisers familiar with soils and farming in the Area. Yields are given separately for (1) principal dryfarmed crops; (2) principal irrigated orchard crops; and (3) irrigated hay and pasture.

The estimates are averages for a period of years. In any given year, the yield of any crop may be more or less than the figure shown.

Dryfarmed crops

Table 2 gives estimates of yields for the principal dryfarmed crops. Only the soils on which the crops are commonly grown are listed. The grain yields are for the year of harvest, which is every other year. Winter wheat is generally the most suitable crop. Spring wheat is usually grown only when fall-seeded wheat is winterkilled. Barley and rye are grown mainly because of restrictions on the amount of wheat that can be planted.

Yields shown in table *2* are those obtained under improved management. Under this level of management, fertilizer rates are determined by needs based on soil tests, by the amount of moisture available at the time of application, by the amount of moisture expected during the rest of the growing season. and by the amount of straw residue that is likely to be left on the surface after harvest. If wheat is grown on the deep and moderately deep soils in the survey area, fertilizer is needed. Generally, about 35 to 45 pounds of available nitrogen is applied in the 9- to 12-inch precipitation zone and about 40 to 60 pounds in the 12- to 15-inch zone. Barley is fertilized in the 9- to 15-inch precipitation zone, and rye in the 7- to 9-inch zone. Sulfur is applied occasionally, when soil tests indicate it is needed.

The soils are tilled so that they retain all possible moisture. They are seeded late in summer or early in fall. Deep-furrow disks are used for seeding. Straw mulch on the surface is managed by fall chiseling; spring sweeping, and skew treading. Rod weeders are used to kill weeds, particularly cheatgrass, but weedings are kept to a minimum.

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

For nonirrigated hay and pasture crops grown under improved management, nitrogen is applied if grass is grown alone, and phosphate and trace elements, such as boron and sulfur, are applied to legumes. All fertilizer is applied according to the needs indicated by soil tests. Generally the rates are. about 90 pounds of available nitrogen for pasture and 60 to 100 pounds for hay. Hay and pasture fields are harrowed or springtoothed in spring to level gopher and other mounds. Fields badly infested with gophers are tested by means of a gopher-poisoning machine. Stands of hay and pasture are plowed and reestablished about every 5 years because of weed infestations and thinning of stands. Grazing is occasionally deferred and rotated to help plants maintain good vigor. Plants are not pastured until growth reaches about 8 inches in spring.

Irrigated orchard crops

Estimates of yields for the principal orchard crops grown in the Chelan Area are given in table 3. Only the soils on which orchard crops are commonly grown are 1isted.

Specific management practices, by crops, under which a farmer obtains the yields shown in table 3 are briefly discussed in the following paragraphs.

Apples and pears.-Trees are fertilized with 1/4 pound to 4 pounds of nitrogen per tree, depending on needs established by soil tests, age of the tree, type of cover crop, and condition of the tree, but. nitrogen never exceeds 100 pounds per acre. Trace elements are applied by means of foliar sprays when needed. During the growing season, 2 to 5 inches of irrigation water is applied every 5 days to 3 weeks at a. rate. of 0.20 to 0.25 inch per hour. Trees are pruned, thinned., sprayed, and maintained in accordance with practices recommended by State and Federal agencies.

Soft fruits.-Trees are fertilized with 1/4 pound to 5 pounds of nitrogen per tree, depending on needs indicated by soil tests, age of the trees, type of cover crop, and condition of the trees. Trace elements are applied by means of foliar sprays. During the growing season, 2 to 5 inches of irrigation water is applied every 5 days to 3 weeks at a rates of 0.20 to 0.25 inch per hour. Other management practices are performed in accordance with recommendations of State and Federal agencies.

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

Irrigated hay and pasture

About 5.000 acres of irrigated hay and pasture is in scattered small fields in the survey area. Under an improved level of management, yields that have been obtained on most of the irrigated soils for alfalfa hay is 5 to 6 tons per acre; alfalfa and grass hay, 6 to 8 tons per acre; grass hay, 4 to 5 tons per acre: alfalfa an grass pasture, 12 to 16 animal-unit-months per acre; clover and grass pasture, 10 to 15 animal-unit-months per acre; and grass pasture, 8 to 10 animal-unit-months per acre.

The management practices needed to obtain these yields are briefly described in the following paragraphs.

Alfalfa hay.-Fertilizer is applied in split applications with a total of 40 to 60 pounds of phosphate and trace elements on the basis of needs indicated by soil tests; proper irrigation is practiced; and good growth is left going into winter to maintain plant vigor.

Alfalfa and grass hay.-Fertilizer is applied in split applications with a total of 60 to 100 pounds of nitrogen, 50 to 60 pounds of phosphate, and with trace elements based on needs indicated by soil tests; proper irrigation is practiced ; the proper grass-alfalfa balance is maintained; hay is cut at the proper times; and good growth is left going into winter.

Grass hay.-Fertilizer is applied in split applications with a total of 90 to 140 pounds of nitrogen and with trace elements as based on needs indicated by soil tests; proper irrigation is practiced; hay is cut at the proper times; and good growth is left going into winter.

Alfalfa-grass and clover-grass pastures.-Fertilizer is applied in split applications with a total of 80 to 100 pounds of nitrogen. 50 to 60 pounds of phosphate, and with trace elements based on needs indicated by soil tests; proper irrigation is practiced; cross fences are used; stock is moved at proper times; the pastures are clipped as required; manure is spread; forage is supplemented with hay or straw; and the proper grass-alfalfa balance is maintained.

Grass pastures.-Fertilizer is applied in split applications with a total of 100 to 150 pounds of nitrogen and with trace elements based on needs indicated by soil tests; irrigation is performed correctly; cross fences are used; stock is moved at the proper times; the pasture is clipped as required:, and manure is spread.

Range

About 52 percent, or 157,340 acres, of the survey area is in range. Most of the area below an elevation of 3,000 feet is range. Stony, sandy, shallow, and steep to very steep soils and Rock land are generally used for range.

Range sites and condition classes

In order to manage range properly, the operator should know the different range sites on his range and the present and potential plants each is capable of growing. A range site is a distinctive kind of range that differs from other kinds in its potential to produce native plants. The soils that are capable of producing the same kinds and amounts of original plants are grouped into range sites. Soil factors that cause differences in native vegetation are mainly depth, texture, wetness, reaction, exposure, and elevation. The climatic conditions of precipitation, temperature, sunlight, and wind also influence the kinds and amount of plants that grow on the different range sites.

A range condition rating for each range site is needed for range and livestock management purposes. Range condition (fig. 12) is the present state of vegetation on a range site in relation to the potential plant community for that site. Range condition classes are an ex-

A. E. Young., range conservationist, Soil Conservation Service, helped to prepare this section.

Figure 12.-Native range in excellent condition. Soil is Colockum silt loam, 8 to 15 percent slopes.

pression of the degree to which the present plant composition, expressed as a percentage, has departed from the potential, or climax, plant community of a range site.

The range is in excellent condition if 76 to 100 percent of the stand consists of the original plant cover. It is in good condition if the percentage is between 51 to 75; in fair condition if the percentage is between 26 to 50; and in poor condition if it is 25 or less.

The purpose of determining range condition is to provide an appropriate basis for planning the use, treatment, and management of range that will assure soil protection, high water quality, and optimum production of forage.

Descriptions of the range sites

The range sites in the survey area are described in the following pages. The description of each range site gives the important soils, the principal plants, and other information on the use and management of the site for range.

To learn the range site for any given soil in the survey area, refer to the " Guide to Mapping Unit" at the back of this survey. Range condition guides and treatment specifications are available at the local office of the Soil Conservation Service.

SANDY RANGE SITE

Quincy loamy fine sand, 0 to 15 percent slopes, is the only soil in this site. This is an undulating soil adjacent to or near the Columbia River and the lower Wenatchee River. This site occupies about 200 acres. Average annual precipitation commonly ranges from 7 to 10 inches, and most of it falls in winter. Summers are hot and dry. The period most favorable for plant growth is from March 15 to June 1.

Approximate composition of the climax (potential) plant community, by weight, is 85 percent needle-and-thread; 2 percent Indian ricegrass and thickspike wheatgrass; 2 percent bluebunch wheatgrass and sand dropseed; 3 percent balsamroot, biscuitroot, and fleabane; 2 percent hawksbeard, buckwheat, and tarragon; 2 percent dog parsley, veiny dock, and scurfpea; and 3 percent bitterbrush, big sagebrush, and rabbitbrush.

If the range is subject to grazing abuse or fire, needle-and-thread, Indian ricegrass, and bluebunch wheatgrass decrease. Buckwheat, fleabane, veiny dock, rabbitbrush, and less palatable plants increase. Under continued abuse of the range, annual bromes, annual fescue, Russianthistle, tarweed, prickly lettuce, and mustard become abundant.

If this site is in excellent condition, the total annual production of herbage per acre, air-dry weight, ranges from 400 pounds in unfavorable years to 700 pounds in favorable years. About 80 percent of the plants furnish forage for livestock.

This site is subject to soil blowing and trampling damage by grazing animals during the dry season. It is best suited to grazing late in fall and in winter. The shrubs are important winter forage and cover for big game animals.

SHALLOW RANGE SITE (S-2)

The soils of this site are moderately coarse textured and medium-textured and are mostly shallow or moderately deep. Some of the soils are deep or very deep, but

these soils have either a steep south exposure or a subsoil of clay loam, or both. Those soils that have a clay loam subsoil produce natural plant communities that are very much like those of shallow soils. This site occupies about 69,200 acres and is the largest range in the survey area. Slopes range from 0 to 65 percent, but most are steep and very steep. The steep soils lose water by evaporation and runoff, thus reducing moisture for plant growth. The average annual precipitation ranges from 8 to 16 inches. Precipitation falls mostly during the winter season. The summers are hot and dry. The period most favorable for growing is from mid-March to the first. of June. The earliest plants are on steep soils that have a south exposure. These plants also mature first.

Approximate composition of the climax (potential) plant community by weight is 70 percent bluebunch wheatgrass; 10 percent Sandberg bluegrass; 5 percent Thurber needlegrass and needle-and-thread; 3 percent fleabane, biscuitroot, and yarrow: 2 percent. Hooker balsamroot, lupine, and carrotleaf: 3 percent buckwheat, penstemon, and arrowleaf balsamroot; 2 percent phlox, hawksbeard, and woollypod milkvetch; and 5 percent rabbitbrush, big sagebrush. and bitterbrush.

If the range is abused, bluebunch wheatgrass decreases and is replaced by lupine, yarrow, balsamroot, rabbitbrush, big sagebrush. and other minor plant species. Under continued abuse of the range, these plants are replaced by cheatgrass brome, fiddleneck, mustard, thistle, and other weedy plants that. invade the site.

If this site is in excellent condition, the total annual production of herbage per acre, air-dry weight. ranges from 400 pounds in unfavorable years to 700 pounds in favorable years. About 70 percent of the plants furnish forage for livestock.

This site is subject to water erosion when bare of vegetation and litter. It is best suited to grazing in spring and fall. It is used as winter range by deer.

Reseeding and brush control are feasible on the gentle slopes when range condition is too poor to permit satisfactory improvement from grazing management alone.

SANDY LOAM RANGE SITE

The soils of this range site are moderately coarse textured and medium textured and have a moderate to large amount of gravel and cobblestones in the. profile. These soils tend to be drought-. This site occupies about 7,600 acres. Slopes range from 0 to 45 percent. Average annual precipitation ranges from 8 to 13 inches, and it falls mostly in winter. The summers are hot and dry. The period most favorable for growing is from late March to early June.

Approximate composition of the climax (potential) plant community by weight is 60 percent. bluebunch wheatgrass; 15 percent needle-and-thread and Thurber needlegrass; 5 percent prairie junegrass and Sandberg bluegrass; 5 percent balsamroot, fleabane, and hawksbeard; 5 percent big sagebrush, bitterbrush, and rabbitbrush; 5 percent yarrow, lupine, and biscuitroot; and 5 percent buckwheat, milkvetch and wormwood.

If the range is subjected to grazing abuse or burning, bluebunch wheatgrass and Thurber needlegrass decrease and Sandberg bluegrass, needle-and-thread, balsamroot. yarrow, lupine, and rabbitbrush increase. Under continued abuse of the range, annuals and brushy species eventually dominate. Big sagebrush and bitterbrush are easily killed by fire.

If this site is in excellent condition, the total annual production of herbage per acre, air-dry weight, ranges from 500 pounds in unfavorable years to 1,000 pounds in favorable years. About 80 percent of the plants furnish forage for livestock.

The site is vulnerable to damage from trampling and soil blowing when the surface is dry and plant cover is reduced. It is best suited to grazing in fall, winter, and spring. Seeding and brush control are feasible when needed.

LOAMY RANGE SITE (L-2)

The soils of this site are moderately deep to very deep, moderately coarse textured and medium-textured soils that have rock outcrop in places. This site occupies about 35,000 acres. Slopes range from 0 to 45 percent. Average annual precipitation ranges from 8 to 16 inches. Precipitation falls mostly in winter. The summers are hot and dry. The favorable period for growing is from late March to mid-June.

Approximate composition of the climax (potential) plant community by weight is 50 percent bluebunch wheatgrass; 25 percent Idaho fescue. and Cusick bluegrass; 5 percent needle-and-thread, Thurber needlegrass, and Columbia needlegrass; 5 percent big bluegrass and prairie junegrass; 5 percent threadleaf sedge and Sandberg bluegrass: 5 percent balsamroot. biscuit, and phlox:: 2 percent fleabane, buckwheat, yarrow, and mountain dandelion; 2 percent lupine, hawksbeard, and gromwell; and 3 percent big sagebrush. rabbitbrush, bitterbrush, and three-tip sagebrush.

If the range is abused, bluebunch wheatgrass. Idaho fescue, and Cusick bluegrass decrease and Sandberg bluegrass, needle grasses. balsamroot, lupine. yarrow, big sagebrush, rabbitbrush. and other similar plants increase. Continued abuse of the range results in invasion of cheatgrass brome, prickly lettuce, mustard, tarweed, diffuse knapweed, and other weeds foreign to the site.

If this site is in excellent condition, total annual production of herbage per acre, air-dry weight, ranges from 700 pounds in unfavorable years to 1,400 pounds in favorable years. About 80 percent of the plants furnish useful forage for livestock.

If this site is in poor condition, reseeding is practical on soils that are relatively free of stones or rock outcrop and that have slopes of less than 45 percent. A seedbed should be prepared and the seeds drilled. Brush control is feasible where there is an excess of useless woody plants. This site is best suited to grazing in spring and
fall.

NORTH EXPOSURE RANGE SITE (N-1)

The soils in this site are moderately deep to very deep. They are moderately coarse textured and medium textured and are on north exposures where slopes range from 15 to 65 percent but are mostly 25 to 45 percent. This range site occupies about 26,900 acres. Average annual precipitation ranges from 8 to 16 inches. Snow accumulates on north exposures and evaporation is less because of reduced wind and sunlight.

Approximate composition of the climax (potential) plant community by weight is 60 percent Idaho fescue and Cusick bluegrass; 20 percent bluebunch wheatgrass and big bluegrass: , 5 percent Sandberg bluegrass and prairie junegrass; 3 percent lupine, waterleaf. and yarrow; 2 percent groundsel, milkvetch, and hawksbeard; 2 percent pearleverlasting, aster, and biscuitroot; 3 percent buckwheat, phlox, and grornwell ; 3 percent three tip sagebrush and rabbitbrush ; and 2 percent rose, snowberry, serviceberry, and mockorange.

If the range is abused. Idaho fescue, Cusick bluegrass. and bluebunch wheatgrass decrease and are replaced by Sandberg bluegrass, lupine, rabbitbrushes, and other hardier, less palatable or more fire-resistant plants. Continued abuse further retards the range condition and allows cheatgrass brome, fiddleneck, salisfy, thistle, big sagebrush, and other weedy plants to invade the site.

If this site is in excellent condition, the total annual production of herbage per acre, air-dry weight, ranges from 750 pounds per acre in unfavorable years to 1,600 pounds in favorable years. About 85 percent of the plants in the potential plant community are those that furnish forage for wildlife and livestock.

The soils in this site are generally too steep for reseeding. They are generally best suited to grazing in summer and early in fall. Water erosion is a hazard on this site when vegetation and litter are reduced too greatly.

VERY SHALLOW RANGE SITE

This range site is on very shallow and shallow, rocky soils that have very low available water capacity. It occupies about 6,200 acres. Slopes range from 25 to 65 percent. Average annual precipitation ranges from 8 to 12 inches, and most of it falls in winter. Summers are hot and dry. The period most favorable for growing is from April 1 to May 15.

Approximate composition of the climax (potential) plant community by weight is 55 percent Sandberg bluegrass ; 3 percent bluebunch wheatgrass and Idaho fescue ; 2 percent squirreltail and Thurber needlegrass; 2 percent sandwort, fleabane, and goldenweed ; 3 percent hooker balsamroot, lupine, and penstemon; 5 percent phlox. violet, and wild onion; and 30 percent stiff sagebrush and shrubby buckwheat.

Excess trampling by grazing animals on this site when the soils are saturated causes Sandberg bluegrass to decrease. Stiff sagebrush and shrubby buckwheat decrease after a fire.

If this site is in excellent condition, the total annual production of herbage per acre, air-dry weight, ranges from 175 pounds in unfavorable years to 300 pounds in favorable years. About 60 percent of the plants in this plant community are useful for forage.

This site is best suited to grazing in spring and in fall. Seeding is not feasible because of rock outcrop, steep slopes, and shallow soil depth.

VERY SHALLOW RANGE SITE (C)

This site is on very shallow and shallow soils that are coarse textured and medium textured. Rock outcrop is in places. This site occupies about 9,400 acres. Slopes range from 0 to 65 percent. Average annual precipitation commonly ranges from 12 to 30 inches and occurs mostly in winter and in spring. Summers are cool and have some rains. The period most favorable for growing is from May 15 to July 1. Elevation ranges mainly from 2,000 to 5,500 feet.

Approximate composition of the climax (potential) plant community by weight is 20 percent bluebunch wheatgrass and Idaho fescue; 40 percent Sandberg bluegrass; 2 percent squirreltail and prairie junegrass; 3 percent sandwort and Hooker balsamroot; 2 percent penstemon, phlox, and lupine; 3 percent buckwheat, onion, and pussytoes; and 30 percent low sagebrush and bitterbrush.

Bluebunch wheatgrass and Idaho fescue decrease with overgrazing. Low sagebrush and bitterbrush decrease after a fire. Sandberg bluegrass on the Anatone soils is very susceptible to damage by trampling in spring when the soil is saturated.

If this site is in excellent condition, total annual production of herbage per acre, air-dry weight, ranges from 250 pounds in unfavorable years to 500 pounds in favorable years. About 65 percent of the plants furnish forage for livestock and wildlife.

This site is best suited to grazing in summer and early in fall. Seeding is not feasible, because of rock outcrops, steep slopes, and shallow soil depth.

SHALLOW RANGE SITE (S-3)

This site is on shallow soils. It occupies about 2,000 acres. Slopes range from 0 to 25 percent. Average annual precipitation ranges from 22 to 30 inches, and most of it falls in winter and in spring. Summers are cool and have some rains. The period most favorable for growing is from May 15 to July 1.

Approximate composition of the climax (potential) plant community by weight is 52 percent bluebunch wheatgrass and Idaho fescue; 30 percent rough fescue and prairie junegrass; 5 percent Sandberg bluegrass and onespike oatgrass; 2 percent sedge and oniongrass; 2 percent Columbia needlegrass and squirreltail; 2 percent fleabone. penstemon. yarrow, and pussytoes ; 2 percent lupine, balsamroot, and death camas; and 5 percent shrubby buckwheat and low sagebrush.

If the range is abused. bluebunch wheatgrass, Idaho fescue, and rough fescue decrease and Sandberg bluegrass, squirreltail, yarrow, lupine. shrubby buckwheat, low sagebrush, and other less useful plants increase. Continued abuse eliminates climax species and allows weedy, undesirable plants that are foreign to the site to invade. Examples are cheatgrass brome, mustard, thistle, prickly lettuce, and fiddleneck.

If the site is in excellent condition, the total annual production of herbage per acre, air-dry weight, ranges from 600 pounds in unfavorable years to 1,200 pounds in favorable years. About 85 percent of the plants in the potential plant community produce forage for livestock.

This range site is subject to water erosion when it lacks plant, cover. It is well suited to grazing late in spring and early in summer. Elk use this site for spring grazing.

The soil is too stony for seedbed preparation or for drilling. If range condition indicates revegetation is needed following wildfire, broadcast seedings are usually successful.

MOUNTAIN PARK RANGE SITE

Jumpe stony silt loam, thick surface variant, 8 to 25 percent slopes, is the only soil in this site. This site occupies about 220 acres. The average annual precipitation ranges from 25 to 30 inches. Most precipitation falls in winter and in spring. Summers are cool and have some rains. The periods most favorable for growing is from May 15 to July 1.

Approximate composition of the climax (potential) plant community by weight is 50 percent needlegrass and slender wheatgrass ; 15 percent mountain brome and hairgrass; 15 percent Nevada bluegrass and Kentucky bluegrass ; 10 percent sedge and rushes ; 2 percent penstemon, clover, and solomonplume; 5 percent yarrow, dandelion, and hawkweed ; and 3 percent aster, silene, and cinquefoil.

If the range is abused, Nevada bluegrass, slender wheatgrass, and mountain bromegrass decrease and needlegrasses, Kentucky bluegrass, and yarrow are major species that increase. Under continued abuse of the range, these better plants are replaced by bullthistle, mullein, mustard, and other weedy invaders of low grazing value.

If this range is in excellent condition, annual production of herbage per acre, air-dry weight, ranges from 1,500 pounds per acre in unfavorable years to 3,000 pounds in favorable years. About 90 percent of the plants in the potential plant community are useful for forage.

When this range site is in poor condition, a seedbed should be prepared and drill seeded. Generally, brush control is not needed. This is an excellent site for summer and fall grazing by livestock and elk.

WET MEADOW RANGE SITE

Peoh silt loam is the only soil in this site. This site occupies about 620 acres. Slopes range from 0 to 3 percent. Average annual precipitation ranges from 15 to 25 inches. Precipitation falls mostly in winter and in spring. Summers range from hot and dry at lower elevations to cool with some rain at higher elevations. The periods most favorable for growing are from May 1 to August 15 at lower elevations and from June 1 to September I at higher elevations.

Approximate composition of the climax (potential) plant community by weight is 60 percent tufted hairgrass and slender wheatgrass; 10 percent timothy, slender hairgrass, and redtop ; *15* percent sedge, rushes, and cattail ; 5 percent Kentucky bluegrass, quackgrass, and foxtail barley ; 3 percent cinquefoil, buttercup, iris, and mint; 3 percent cowparsnip, waterhemlock, and arrow grass; and 4 percent alder, willow, and aspen.

If the range is overgrazed, tufted hairgrass, slender wheatgrass, and timothy decrease and redtop, sedges, rushes, foxtail barley, quackgrass, and willows increase. Under continued overgrazing, iris, bullthistle, dock, mullein, and fireweed invade this site.

If this site is in excellent condition, the total annual production of herbage per acre, air-dry weight, ranges from 3,000 pounds in unfavorable years to 6.000 pounds in favorable years. About 90 percent of the plants in the potential plant community produce forage for livestock and wildlife.

When this site is in poor condition. reseeding to domestic grass species is feasible. A seedbed should be prepared during dry periods to eliminate weeds. This site is best suited to grazing in summer.

Woodland

Forests cover approximately 76,000 acres, or about 25 percent, of the survey area. They are located in the southeastern, western, and extreme northern parts of the area.

The principal woodland product is lumber, but minor amounts of Christmas trees, wood chips, and other forest products are also produced. The important species for timber are ponderosa pine and Douglas-fir. Minor amounts of grand fir, larch, and lodgepole pine are also useful.

Some forest lands have been cleared for farming. These areas consist mostly of Cle Elum, Leavenworth, and Wintoner soils. The majority of private forest lands have been logged one or more times. Intensive woodland management practices, such as thinning of stands and erosion control, are beginning to be followed on large timber holdings and have gained acceptance on small, private tracts (fig. 13).

The woodlands of the Chelan Area are important as recreation areas, wildlife habitat, and watershed. Scout and community camps, as -well as numerous excellent public campground areas in adjacent national forest lands, attract campers and hikers. Large numbers of elk and deer use these private woodlands for winter feed areas. Irrigation reservoirs built for irrigating cropland in the lower valleys are filled by runoff from the woodlands.

Woodland suitability groups

Similar soils commonly have essentially the same response to woodland use and management. Because of this, and to simplify interpretations, soils that perform similarly in woodland use are separated into groups These groups of soils are called woodland suitability groups. Table 4 describes these groups, their rates of production, and their limitations for woodland use and management.

Soil properties that affect tree growth are texture, structure, organic-matter content, depth, reaction, aspect, and position. Attempts to measure the specific effect of the individual soil properties have met with limited success. However, the combination of all soil properties has a marked effect on tree growth and management. The woodland interpretations given in table 4 are based on the combined effects of all soil factors pertinent to the growth of trees.

Woodland groups are identified by a three-part symbol, for example, 2o1. The first part is a numeral that corresponds to the site class or relative productivity of the soil: *1, very high; 2, high; 3, moderately high; 4, moderate;* and *5, low.*

The second part is a letter that indicates features that produce moderate or severe hazards or limitations in

LARRY LENZ, forester, Soil Conservation Service, helped prepare this section.

Figure 13.-Thinning and pruning of ponderosa pine on Stemilt silt loam, 0 to 25 percent slopes.

managing the soils for the production of wood crops. The letter *o* means that the soil has no significant limitations for woodland management; *r*, that the soil has steep slopes; and *x*, that stones or rocks are a limitation.

The third part of the symbol identifies the woodland suitability group within each subclass.

In the following paragraphs the terms used in table 4 are briefly explained.

Seedling mortality ratings are based on soil-caused mortality for naturally occurring or planted seedlings. Where the rating is slight, expected mortality is 0 to 25 percent; where moderate, between 25 and 50 percent; where severe, more than 50 percent.

Erosion hazard is slight if problems of erosion control are unimportant ; moderate if some attention must be given to prevent unnecessary erosion; high if intensive treatments, specialized equipment, and methods of operation must be planned to minimize soil deterioration; and very high if extreme erosion hazards require special methods of operation to minimize soil deterioration.

Windthrow hazard is slight if normally no trees are blown down by the wind, moderate if some trees are expected to be blown down during periods of excessive soil wetness and high wind, and severe if many trees are expected to be blown down during periods of soil wetness and moderate or high winds.

Plant competition is slight if competition does not prevent adequate natural regeneration and early growth and does not interfere with adequate development of planted seedlings. It is moderate if competition delays natural or artificial regeneration; that is, it affects both establishment and growth rate, but it does not prevent the eventual development of fully stocked normal stands. It is severe if competition prevents adequate natural or artificial regeneration without intensive site preparation and weeding.

Equipment limitations are slight if equipment use is not restricted in kind of operation or time of year. They are moderate if equipment use is moderately restricted in kind of operation by slope, rockiness, seasonal soil wetness, texture, injury to tree roots, soil structure, stability, or other factors. They are severe if special equipment is needed and its use is severely restricted by the need to assure safety in operations and by slope, stones or obstructions, seasonal soil wetness, physical soil wetness, physical soil characteristics, injury to tree roots, soil structure, stability, or other factors.

Potential soil productivity refers to the estimated yield by tree species that a given soil can produce under a. specified level of management. Site index is the most common measurement of woodland productivity of soils. It is the average height attained by dominant and codominant trees in the stand at 100 years of age. Site index can be grouped

into five or seven classes. The site index range within each class is as follows : Class I is more than 113 feet (None in survey area) ; class II is 99-112 feet; class III is 85-98 feet; class IV is 71-84 feet and class V is 57-70 feet.

The production estimates, site index ratings, and site classes for ponderosa pine in this survey are based on data in USDA Bulletin 630 (6) those. for lodgepole pine are based on USFS Research Paper RM-29, Site Indexes for Lodgepole Pine With Corrections for Stand Density (9). Because adequate yield tables have not been developed for inland Douglas-fir, the data for ponderosa pine were used !and correlated with existing data on Douglas-fir. The yield of ponderosa pine is given in table 5.

Wildlife

Before 1876 most land in the Chelan Area was used by some species of wildlife. Bear, cougar, bobcat, rabbits, coyote, deer, mink, muskrat, beavers, and wolves were present. Ducks, geese, grouse, doves, and nongame birds were abundant before the prairie sod was plowed. Marmot, rabbits, and rattlesnakes were present in the more rocky and drier parts of the Area. Perennial streams such as Peshastin, Chumstick, Entiat, Icicle, and Nason were clear and well supplied with fish. The Columbia and Wenatchee Rivers had large annual runs of salmon and steelhead. Lakes Wenatchee, Fish, and Chelan were well stocked with trout. The lakes, streams, rivers, grasslands, wooded bottom lands, and timbered mountain slopes formed an excellent habitat for a large and varied wildlife population.

Since 1876 about 55,000 acres in the survey area has been put under cultivation, and much of the rest has been grazed, some severely, by livestock. Approximately 75,000 acres of woodland are being cutover for the second or third time. There is no longer food and cover for the sage grouse and prairie chicken. Beaver, waterfowl, and some trout have left the streams. Deer and elk have lost much of their winter range. Deer have retreated to the higher elevations of the uplands, and most of the furbearing animals have disappeared.

Elk from the Yellowstone herd in Montana were released in the Yakima-Kittitas area in the spring of 1913. The herd is now well established. The mountainous southern part of the survey area is part of their habitat.

Trout and silver salmon are planted annually in Lake Wenatchee. Trout are planted in Fish Lake, the Wenatchee River, Icicle River, and several other streams and lakes in the Area.

Ring-necked pheasant, California quail, and Hungarian and chukar partridges have been introduced to the Area. They have become established and furnish good hunting. Turkeys and bighorn sheep have recently been introduced.

Each year an increasing number of hunters come to the Area for upland game birds, deer, and elk. If this trend continues, landowners, individually or in groups, may find it economically feasible to devote some of their land to the production of game birds and animals for fee hunting.

Each soil in the survey area has some potential for providing food, cover, or water for some species of wildlife, but rarely does a single soil provide all elements of habitat needed for a single species. Blue grouse nest in the grasslands, then move the brood into wooded area. Elk graze on one soil early in spring and on another in fall. Some soils are better suited to grass, others to woody shrubs, and still others to trees. Where these soils occur in proper spacial or topographic relationship. they complement each other in supplying food and shelter for wildlife.

Each of the nine soil associations in the survey area is a combination of topographic features, soils, and plant species that is suitable for one or more species of wildlife.

Important species of wildlife and some general suggestions for wildlife management are discussed, by soil associations, in the following paragraphs.

1. Burch-Cashmont association.-This association furnishes relatively poor habitat for most wildlife species, but it is used by a few ring-necked pheasants, songbirds,
Hungarian partridges, rabbits, coyotes, and doves. Most

In the original manuscript, there was a table in this space.
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of the acreage is used for irrigated orchards. Toxic sprays used in these orchards to control orchard pests are detrimental to wildlife. Managing the soils in this association for wildlife is difficult. High fences to keep deer out of orchards in winter and in spring are necessary in certain deer wintering areas to prevent damage to young trees and to low limbs on older trees.

2. Chelan-Margerum association.-This is an important association for doves and chukars, and some coyotes, pheasants, grouse, and quail are also present. This association is also an important wintering area for deer. A moderate acreage of this association is used for irrigated orchards, which generally have a high fence around them to keep deer out. The bird population is quite low in the irrigated orchards because orchard sprays are used.

Good range management practices help to maintain a supply of range plants for cattle and browse for deer. Providing watering facilities at suitable locations and planting patches of food, preferably wheat, in areas of deep soil help to increase the number of game birds. Deferring grazing until after the chukar nesting season helps to protect nesting cover and to increase the number of young.

3. Thow-Nevine association.-A combination of heavy timber, open brushy slopes, and a few cultivated fields makes this association good deer and ruffed grouse habitat. The area also supports a few elk, bear, and bobcat. Because of the abundance of trees, brush, and forbs, these soils produce better habitat for deer than range for livestock. Range cattle graze on abandoned farmland, in burned areas, and along skidways. They do riot use the browse thickets until after the grassy areas have been grazed off. Good range and woodland management is needed to maintain a strong wildlife population. Establishment of water developments would help to increase the deer population on the Thow soils.

4. Brief-Leavenworth association.-This association supports a cross section of wildlife, including a fairly large number of doves, quail, and grouse. Some deer, bear, bobcat, rabbits, pheasants, and coyotes also use the area. Some of this area has irrigated orchards. and here wildlife tends to be more limited because sprays are used. Almost all orchards have tall fences to keep deer out. Planting perennial vegetation in field borders and around the edges of pasture and havland helps to increase the number of game birds. Good range and woodland management is needed to maintain a strong wildlife population.

5. Anatone-Jumpe association.-Elk hunting is very popular in this association. Deer, bear, grouse, and quail also are here. Cattle graze mostly on the Anatone, Longridge, and Jumpe soils in this association. They are the browse thickets after the grassy areas are grazed off. The timbered and brushy areas are better suited to habitat for elk and deer than to range for livestock. Good range and woodland management is needed to preserve the food supply and to maintain a strong wildlife population.

6. Bjork-Zen association.-The important wildlife in this association are pheasants, quail, and partridges. There are a few chukars, deer, rabbits, and coyotes. This is a fairly important wintering area for deer.

Watering facilities located near wheatfields and on rang eland in good or excellent condition would materially aid in establishing new colonies of game birds. The best sites would have accessibility to grainfields. Establishment of brush fence rows and other grassy and brushy areas of ditchbanks, waterways, and the like, as well as prevention of overgrazing by livestock, would also help to build up the bird and deer population. Leaving patches of unharvested grain near good winter cover would favor an increase in the number of game birds.

7. Entiat-Dinkelman association.-This association is an important wintering area for deer that come down from higher elevations late in fall. In summer this association is an important habitat for doves and chukars and for some coyotes, grouse, pheasants, bear, and quail. The deer graze on bitterbrush and other brush, forbs, and grasses. Chukars like the steep, rocky slopes leading down to the Columbia River. Their chief food is cheatgrass that invade this association as a result of overgrazing.

Good range management helps to maintain areas of range for cattle and browse for deer. Providing watering stations at selected locations would help to increase the number of game birds. Establishment of brushy areas in the steep, north-facing coves of drier areas would favor an increased bird and (leer population.

8. Nard-Stemilt association.-This is an important soil association for deer and grouse. A combination of pine thickets; a few open, brushy, south-facing slopes; and grassland areas make this good habitat for deer. Some bear, turkey, bobcat, elk, and game birds are also present. This association is a fairly important wintering area for deer and a very important wintering area for elk.

All species of wildlife make good use of irrigation water supply reservoirs on the Stemilt soils. Because of the abundance of browse and forbs, these soils are better suited to habitat for deer than to range for livestock. Range cattle graze on abandoned farmland, in burned areas, and along skidways. They generally do not use the browse thickets until the grassy areas are grazed off. Good range and woodland management is needed to maintain a strong wildlife population.

9. Rock outcrop-Rock land-Terrace escarpments association.-Only a small amount of wildlife visit this association. Most of this association consists of steep, almost bare, rocky slopes or gravel areas near streams. Some doves, pheasant, chukars, and quail are in brushy areas near the streams. and a few are on the steep terrace breaks. Planting brushy areas on steel) breaks would help to increase the number of birds in these areas.

Engineering Uses of the Soils

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 commissioners, town and city managers, land developers, engineers, con tractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction charac-

teristics, soil drainage condition, shrink-swell potential, grain size, 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 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 of the soil survey 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 performance of structures already built with 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 6 and 7, which show, respectively, several estimated soil properties significant to engineering and interpretations for soil properties for various engineering uses.

This information along with the soil map and other parts of this publication can be used to make interpretations in addition to those given in tables 6 and 7, 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 that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have different meanings in soil science than in engineering. The Glossary 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 for engineering are the Unified system (10), used by the SCS engineers, Department of Defense, and others, and the AASHO system (1), adopted by the American Association of State Highway Officials.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. Thereare eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, GP-GM.

The AASHO system 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 ranging 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 that are the poorest soils for subgrade.

Soil properties significant to engineering

Several estimated soil properties significant in engineering are given in table 6. These estimates are made for typical soil profiles, by layers that differ sufficiently 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 6.

In this survey area, depth to seasonal high water table is significant in only a few soils. The water table ranges from 0 to 24 inches in Peoh soils and Riverwash; 24 inches to more than 48 inches in Antilon and Beverly soils and Alluvial land; and 48 inches to more than 60 inches in Leavenworth soils.

Depth to bedrock is the distance from the surface of the soil to the upper surface of the rock layer.

Soil texture is described in table 6 in the standard terms used by the U.S. 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 contains 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 soil survey.

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 6 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available moisture 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 in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

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All tables have been updated and are available as a separate document.

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 causes 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 of material having this rating.

Corrosivity, as used in table 6, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. 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 and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations **of soils**

The estimated interpretations in table 7 are based on the engineering properties of soils shown in table 6, 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 Chelan Area. In table 7, 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 and some other uses. For these particular uses, table 7 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 generally favorable for the rated use, or in other words, limitations that are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive mainte-

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nance. For some uses, the rating of severe is divided to obtain ratings of severe and very severe. *Very severe* means one or more soil properties so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly not practical for the rated use.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Frost action potential is relative and only applies to this survey area.

Following are explanations of some of the columns in table 7.

Topsoil is used for topdressing an area where vegetation is to be established and maintained (fig. 14). Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or its response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance about where to look for probable sources. A soil rated as *a good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and neither do they indicate quality of the deposit.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and the relative ease of excavating the material at borrow areas.

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 a depth of 6 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 rock, and susceptibility to flooding. Slope is a soil property that affects *difficulty* of layout and con-

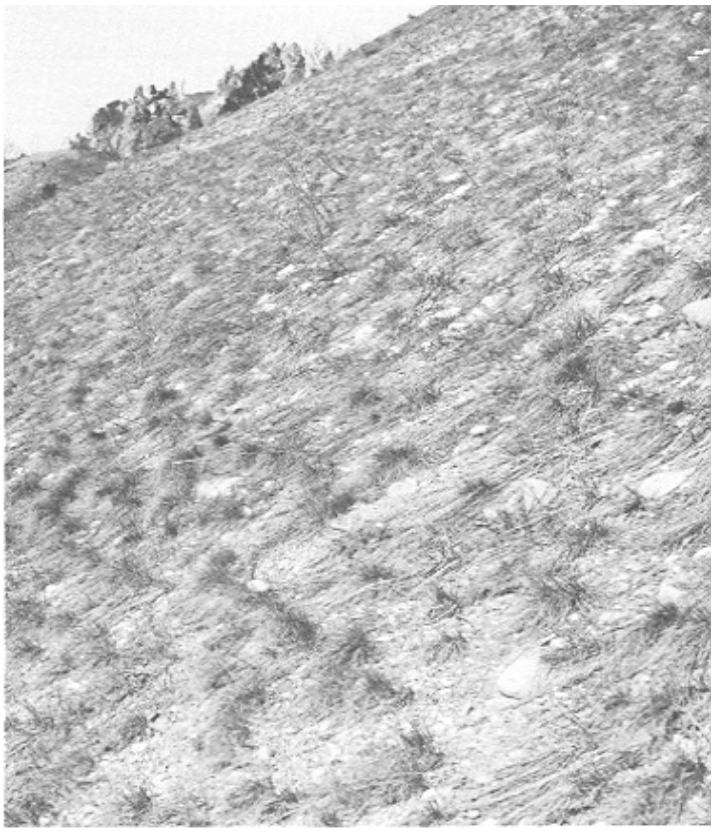

Figure 14.-Roadside bank seeded to Chewings fescue, crested wheatgrass, and sweet clover. Exposed soil is substratum of a Cashmont sandy loam.

struction 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 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, and if the floor needs to be leveled, depth to bedrock becomes important. The 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, that influence the ease of excavation and compaction of the embankment material.

Dwellings, as rated in table 7, in the column Foundations for low building with basements," are not more than three stores 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.

Highway location is af[f]ected by shallowness to rock, a high water table. steep slopes, the hazards of mass sliding and flooding, and other features of the soils.

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 soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or depth to water table or bedrock.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage., which is related to their 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 factors that are unfavorable.

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 provide drainageways that safely remove excess water and reduce the loss of soil. Among the soil features that affect grassed waterways are fertility, slope, drainage, erodibility, depth to the subsoil or to the substratum, soil reaction, depth to the water table, and the hazard of flooding.

Formation and Classification of Soils

This section discusses the major factors of soil formation as they relate to the soils of the Chelan Area. It also briefly explains the current system of classification used in the United States, and each soil series represented in the Area is placed in some of the categories of that system.

Factors of Soil Formation

Soil is a near continuum spread over much of the Earth's surface. It is modified over a period of time by climate and biotic effects, which may be controlled locally by topography. The properties of a soil are determined by five factors: (1) thee physical and mineralogical composition of the parent material; (2) the climate under which the, soil material has accumulated and has existed since accumulation; (3) the topography, or re-

lief, of the land; (4) living organisms; and (5) the length of time the forces of soil formation have acted on the parent material.

Soils differ according to the relative degree of influence of each soil-forming factor. These factors and their influence on the soils of the Chelan Area are explained in the following paragraphs.

Parent material

Soils of the Chelan Area formed in materials weathered from glacial till; glacial outwash; weathered igneous, sedimentary, and metamorphic rocks; and volcanic ash and pumice, and in loess, lake sediment, and alluvium. Volcanic ash and loess make up at least a minor part of the parent material of most soils in the Chelan Area (fig. 15).

During the Pleistocene Epoch, areas in the northern, western, and southern parts of the Area were covered by glaciers. As the ice moved, it mixed the surface materials. This mixture, known as glacial till (ground moraine), was exposed as the ice sheets melted. It was reworked by water only slightly or not at all, -with the exception of the till in the Lake Chelan Area. The till in this Area was reworked by the melting glacial waters and is known as ablation till. In general, the glacial till in the Chelan Area is an unconsolidated, heterogenous mixture of silt, clay, sand, and gravel.

The till in the Lake Wenatchee area is quite stony and bouldery.

In the southern part of the county on and around the Colockum Multiple Use Research Center area, the till contains a large amount of clay. A layer of volcanic ash, pumice, and some loess has been deposited on nearly all of the gacial till in the survey area.

As the ice melted, streams flowing from the ice front and down the rivers removed most of the till in its path. Thick beds of nearly clean gravel, cobblestones, and sand were deposited on terraces and plains and in stream valleys. This material is called glacial outwash. The outwash is made up mostly of fragments of acid igneous and metamorphic rocks.

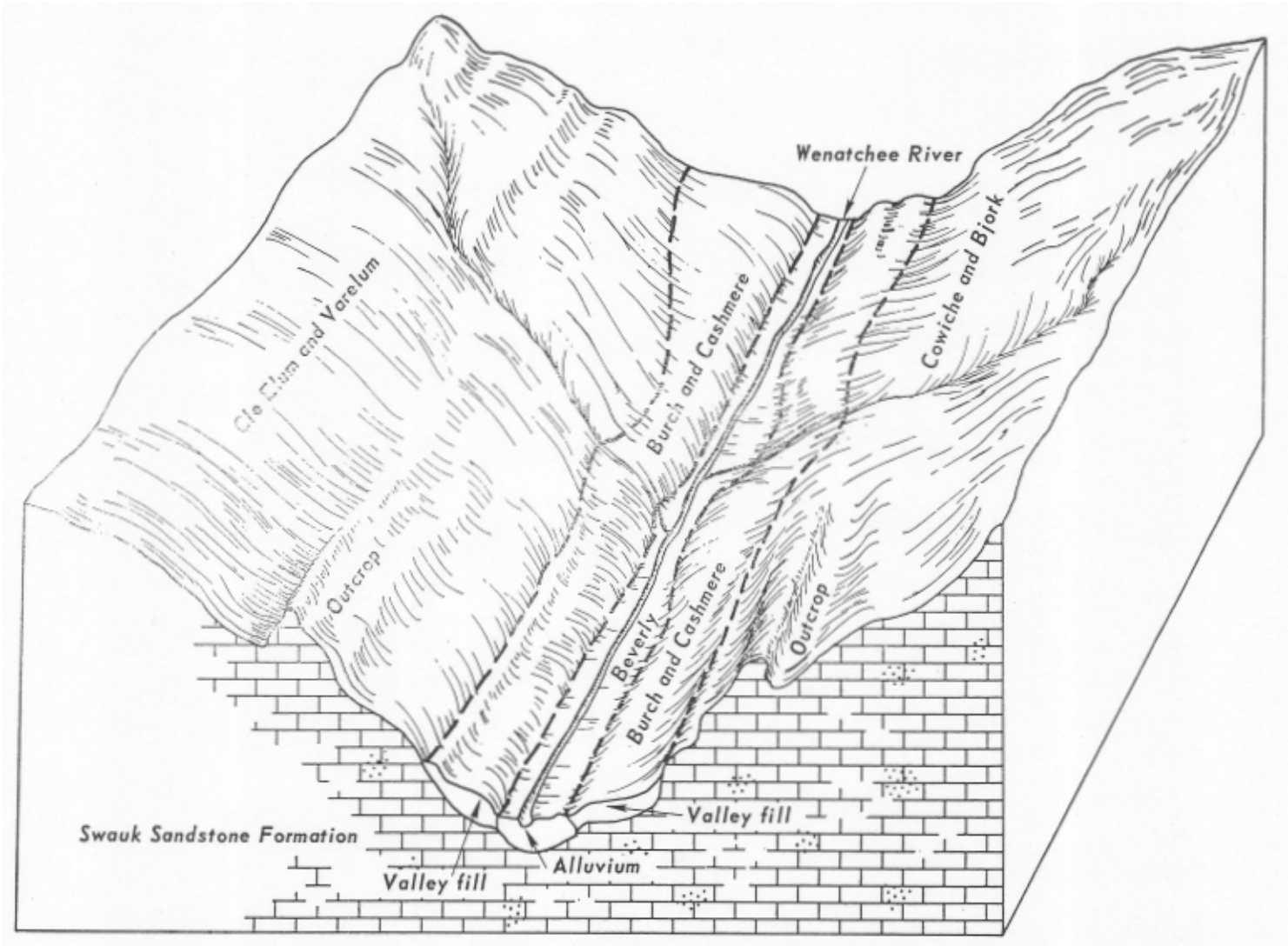

Figure 15.-Cross section of Wenatchee Valley near Cashmere.

A number of soils in the Area formed in weathered granite, granodiorite, gneiss, schist, sandstone, and basalt.

Several soils that formed partly or completely in weathered granite and granodiorite are in the northern part of the survey area from the town of Entiat north to the Okanogan County line. Gneiss and schist are the dominant parent materials of soils from the Wenatchee River north to the town of Entiat. Sandstone occurs around Wenatchee and extends up the Wenatchee Valley past Leavenworth and into the Lake Wenatchee area. Cowiche and Cle Elum soils formed mostly in this sandstone. Soils that are derived partly from weathered basalt and andesite occur mostly in the mountainous area south of Wenatchee in the southern part of the survey area.

Deposits of volcanic ash and pumice vary from only thin layers at. lower elevations to layers 3 and 4 feet thick at higher elevations, as in the Lake Wenatchee area. Deposits also occur in places on steep north-facing and east-facing slopes and terrace breaks. The pumice occurs mostly in the Lake Wenatchee and Lake Chelan areas and down the Columbia River to approximately the town of Entiat. Ash is mixed with the pumice in these areas and exists by itself in the mountainous southern part of the survey area in and around the Colockum Multiple Use Research Center.

The ash and pumice, in the northern part of the survey area. came from Glacier Peak. which erupted approximately 12,000 years ago. In the southern part of the survey area, the ash, mostly the size of coarse silt or very fine sand, probably is a mixture of Glacier Peak and Mount Mazama ash. Mount Mazama erupted approximately 6,600 years ago (3).

Loess, which is wind-deposited, silt-sized particles, is a dominant parent material of soils in the eastern part of the survey area. Loess also has influenced the upper part of most other soils in the Chelan Area. The loess presumably came from the south and east and possibly from local glacial till and outwash. It ranges in thickness from a few inches to 5 or 6 feet.

Associated with the glacial outwash is a moderate acreage of soils that formed in lake sediment. In the Lake Chelan area these deposits are silty, clayey, and nongravelly and are located below areas of glacial till. This sediment occurs on low terraces immediately north of Lake Chelan. In the Wenatchee area it is scattered and usually of small extent.

Recent alluvium is the chief parent material along streams and creeks. This material came from upland areas and was deposited during periods of stream overflow. In most places the material is from a variety of sources and has been transported fairly long distances. In general, the alluvium is quite sandy and gravelly, but in places it is loamy:

Older alluvium (valley fill) is in upland areas around Wenatchee and in the valley from Wenatchee to Leavenworth. This material came from the surrounding valleysides and in places is many feet thick.

Although all the soils have weathered to some extent, the weathering processes have not obliterated the effects of the parent material. For this reason, soils that formed in similar parent materials have many characteristics in common, regardless of variations in climate, relief, living organisms, and length of time the material has been weathering.

Soils in the mountainous southwestern part of the survey area that formed in glacial till contain, in addition to fairly large quantities of clay and silt, many particles coarser than fine sand. Many are stony and cobble. Examples are Loneridge and Tronsen soils. Soils that formed in glacial till in the other areas contain fairly large quantities of sand and gravel, and many are stony and cobbly. Examples of these soils are Nevine, Chelan, and Peshastin soils.

Pogue, Supplee, and Malaga soils are examples of soils that formed in glacial outwash and, therefore, contain quite a large amount of gravel and sand.

Soils that formed partly or completely in material weathered in place from bedrock contain some gravel and sand besides weathered clay, and some are shallow to bedrock. In general they are highly erodible. The Anatone and Bjork soils are examples.

Soils that formed in volcanic ash and pumice are high in content of silt and very fine sand and have a low bulk density. The Chiwawa and Chelan soils are examples.

All soils that formed in loess in the Chelan Area contain large quantities of silt-sized particles, and few, if any, are larger than fine sand. In general, these soils have a fairly high base saturation and are above average in fertility. Ritzville and Margerum soils are examples.

Soils that formed in lake sediment-Ellisforde soils, for example- are high in content of silt, are free of gravel and larger material, and are stratified, at least in the lower part of the soil.

Soils that formed in recent stream alluvium are stratified, sandy, and gravelly. Soils in the Beverly series are an example.

Soils such as Burch and Wenatchee, which formed in old alluvium, are deep, almost gravel free, and quite fertile.

Climate

Temperature and moisture determine, to a large extent, the rate at which minerals are weathered and released to the soil and also the depth at which soluble materials accumulate within the soils; the translocation of fine clay; the reduction and transfer of iron; and the erosion hazard. Temperature and moisture also determine, to a great extent. the amount and kind of vegetation and the rate at which vegetation decomposes.

The annual precipitation in the Chelan Area ranges from 7 to 40 inches. The greatest amount falls in the Lake Wenatchee area. Precipitation increases from east to west, primarily because of the rapid increase in elevation.

Precipitation is lowest in July and August, and it gradually reaches a maximum in midwinter. Most of the precipitation in winter is snow, particularly at the higher elevations.

In January the average temperature at Wenatchee is about 27° F. The soil is generally frozen for a short period in winter. In July the average temperature at Wenatchee is about 73°, and the average annual temperature is about 51°. The temperature becomes progressively lower toward the higher, western part of the survey area. In the extreme western part of the survey

area (Lake Wenatchee), the average January temperature is 24°, the average July temperature is 65°, and the average annual temperature is 45°.

Most of the precipitation falls during the cooler periods of the year. Almost all of the soils are dry or nearly dry during the warm summer months. Consequently, weathering of soil parent material probably proceeds more slowly during these months.

Lime is present in some soils in the Wenatchee area, but with the increasing rainfall to the west it is absent.

In general, the greater the amount of precipitation, the more strongly leached are the soils. The leaching removes lime and lowers pH and base saturation. For example, Jumpe soils receive 30 to 35 inches of precipitation annually and have a pH ranging from 4.8 to 5.2, whereas Burch soils receive 8 to 15 inches annually, and they have a pH ranging from 6.6 to 6.8.

In general, the part of the survey area that receives less than 12 inches of annual precipitation was originally grassland, but the part that receives more than 12 inches was partly forested to fully forested. The surface layer is generally darker and thicker in the 8- to 12-inch precipitation zone than in the more than 12-inch zone. In some soils in the greater than 8-inch precipitation zone, there is evidence of some movement of clay into the subsoil, as evidenced by clay films on the surface of some soil peds.

The partly wooded soils in the transitional zone between forest and grassland have a thin, very dark grayish-brown subsoil. The soils in the heavily timbered areas lack the dark-colored surface layer and are light colored throughout. Some have an A2 horizon.

Relief

The relief of a landscape influences the characteristics of the soil. It affects runoff, drainage, erosion, thickness of soil horizons and profiles, microclimate of the soil, and type and amount of vegetation. Elevation above sea level, steepness, and aspect are important elements of relief in the survey area.

Generally, precipitation increases and temperature decreases as elevation increases. The total plant growth is greater and the breakdown of plant, materials is slower in the foothills of the Cascade Mountains than in the area around Wenatchee.

Chelan Area is characterized by nearly level bottom lands, gently sloping to steep terraces, steep to hilly uplands, and steep to very steep mountainous uplands.

Depressions are in places. In these depressions and in the more poorly drained areas, the A horizon is generally darker and deeper than that in well-drained areas. Poorly drained soils, such as the Peoh soils, have developed distinctive characteristics, such as gray colors and mottles in the subsoil, that are associated with wetness.

On the mountainous uplands, soils that have north-facing slopes are generally deeper. Soils that have south-facing slopes have bedrock protrusions and are shallow in many areas. These soils also receive more direct rays of the sun and have higher temperatures than those that have north and northeast aspects. Evaporation is less on the cooler north-facing slopes, and the effective precipitation is greater, partly because of the additional snow that blows onto them.

Beverly and Leavenworth soils and Alluvial land are next to streams and are subject to occasional overflow and silt deposition.

Living organisms

Plants, micro-organisms, earthworms, man, and other forms of life are important in determining the rate and direction of soil formation. To a large measure, soil formation actually begins when plants begin to grow and animals start to use the plant products. Plants draw moisture and nutrients from the soil, intercept runoff, and reduce soil erosion. Their roots penetrate the earth's mantle and improve aeration and permeability of the soil material. When their life cycles are completed, plant and animal remains are returned to the soil. The decomposition of these remains is one of the fundamental processes in soil formation. The decomposition products enter into chemical reactions with the mineral components of the soil mass. Under certain conditions organic and mineral materials combine and are fixed in the soil. The most obvious effect of vegetation is the addition of organic matter, which tends to darken the color of the soil and to promote a granular-type structure.

In addition, vegetation provides protection against loss of water through runoff and evaporation. Plant roots help to keep the soil supplied with nutrients by returning them from a lower depth to the surface.

Three major vegetative associations have been dominant in Chelan Area. They are responsible for certain properties many soils have in common and for differences in properties among different soils. The three main associations are (1) bunchgrass, mainly deep-rooted perennials; (2) open stands of conifers, mainly ponderosa pine, that have an understory of grass. sedges, forbs, and shrubs; and (3) coniferous forests that consist mainly of Douglas-fir, western larch, ponderosa pine, and white fir and have only a thin understory. On coarse-textured soils or eroded areas, where precipitation is less than 8 inches, needle-and-thread is generally one of the prominent grasses.

Burch, Cowiche, Yaxon, and other soils that formed under bunchgrass have a thick, dark-colored A horizon that has a granular structure. This layer is about 18 to 22 inches thick and is very dark grayish brown to very dark brown. The content of organic matter is 2 to 5 percent. These soils generally occur in the 8- to 12-inch precipitation zone.

Morical and other soils that formed under open stands of conifers have an A horizon that is generally thinner and lighter in color than the A horizon of soils that formed under grass alone. Generally, the content of organic matter is 1 to 2 percent. These soils occur mainly in the 12- to 20-inch precipitation zone.

Generally, in areas where precipitation is more than 20 inches, soils formed under dense stands of conifers and have no A horizon or only a very thin one. Nevine soils, for example, have no A horizon. Soils in heavily timbered regions generally have .a reddish cast when moist, resulting from a release of iron. They also may have an intermittent A2 horizon, and they are generally acid in reaction.

Man has drastically altered soils, especially the upper layers, by clearing forests and by plowing and farming

grassland. The decrease in organic matter and the accelerated erosion in most of the steeper cultivated soils are obvious evidences of man's influence. On the other hand, soils that formed under trees originally had a thin or light-colored A horizon, but in some areas cultivation has resulted in an increase in organic-matter content and a darkening and thickening of the A horizon.

Time

The length of time required for the formation of a given kind of soil depends largely on the interaction of all of the factors of soil formation. An estimate of the age of a soil is generally based on the kinds, thickness, and arrangement of horizons. Generally, the larger the number of horizons. and the greater their thickness and distinctness, the older the soil. Depending upon the nature of the parent material and the vigor of the soil-forming processes, hundreds to thousands of years are required to develop pronounced genetic soil horizons.

The bottom lands along streams periodically receive deposits of fresh material; consequently, these soils are relatively voting and have no perceptible horizons other than A and C horizons. Leavenworth soils, for example, formed in recent alluvium, and they have no B horizon or other evidence of soil development. Their dark color is largely inherited from the parent material, which consists mainly of material eroded from the A horizons of soils at higher positions.

Cowiche, Cle Elum, Morical, Varelum, and Wintoner soils are examples of some of the oldest soils in the survey area. All these soils have a well-developed B2t horizon that has clay films on pod surface and in pores. They all are below the limits of glaciation and are probably older than 9,000 years. All of these soils. except Wintoner soils, formed in place on uplands, partly from weathered sandstone, granite. and granodiorite. Wintoner soils formed in old alluvium.

Most of the other soils in the survey area, such as Ritzville soils, are between the two extremes. Ritzville soils have an A horizon of dark-colored silt loam, a B2 horizon of silt loam that has weak and moderate structure, thin clay films, and an accumulation of carbonates in the C horizon. These soils formed mostly in loess and some volcanic ash and have been forming for less than about 9,000 years.

Soils in the mountains south and west of Wenatchee, centered around the Colockum Multiple Use Research Center, formed mostly in fine-textured glacial till. They probably formed by weathering in place farther up slope and were brought in as clay till by glaciers, probably about 9,000 to 10,000 years ago. Most soils in this area have a loess and volcanic ash surface that is more recent.

Pogue and Malaga soils formed in glacial outwash on terraces near the Columbia River. The outwash is probably 10,000 to 12,000 years old; it formed when the glaciers were melting. Recent evidence suggests the outwash of Malaga soils may be older, perhaps 25,000 years, because the soil material and outwash have a reddish hue and are slightly above the Pogue soils. Soils in the Lake Chelan area have large amounts of pumice and volcanic ash in the upper horizons. This volcanic material came from the Glacier Peak eruption approximately 12,000 years ago, but because of the nature of the material and rather low precipitation, not much soil development has taken place.

Classification of the Soils

Classification consists of an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research. Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge within farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories so that information can be applied to large geographic areas.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (2) and revised later (5). The system currently used by National Cooperative Soil Survey was adopted in 1965 (8). It is under continual study, and readers interested in further details about the system should refer to the latest information available (4).

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup. the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 8 shows the classification of each soil series of the Chelan Area by some categories of the current and 1938 classification systems.

ORDERS.-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 or four syllables ending in *sol.* An example is Mollisol.

SUBORDERS.-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 Xeroll *(Xer,* meaning dry, plus *oll,* from Mollisol).

GREAT GROUPS. Soil suborders are, divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons, soil moisture and temperature regimes. and in base status. 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 and soil. An example is Argixeroll (*Arg*, meaning clay, plus xeroll, the suborder of Mollisols that have a xeric moisture regime).

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SUBGROUPS. Great groups are subdivided into three kinds of subgroups: The central (typic) concept of the great groups (not necessarily the most extensive subgroups) ; the intergrades, or transitional forms to other orders, suborders, or great groups; and extragrade subgroups that have some properties that are representative of the great groups but that do not indicate transitions to any other known kind of soil. The names of subgroups are derived by placing one or more adjectives before the name of the great group. The adjective Typic is used for the subgroup that is thought to typify the great, group. An example is Typic Argixeroll.

FAMILIES. Soil families group soils within a subgroup that have physical and chemical properties that are similar enough that responses to management and manipulation for use are 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 equiva-

lent, 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, reaction, and so on, that are used as family differentiae. An example is Typic Argixeroll, clayey-skeletal, mixed, frigid.

Climate

The climate of Chelan Area is influenced by topography, prevailing westerly winds above the crest of the Cascade Mountains, the path of storm systems crossing the North Pacific, cold air in-asses moving southward from the Arctic region, and distance and direction from the ocean. Most air masses crossing the State have source regions over the Pacific Ocean. Late in spring and in summer, westerly to northwesterly winds from over the North Pacific contribute to a dry season. Late in fall and in winter, southwesterly and westerly winds from over the ocean provide a source of moisture for the wet season, which begins in October, reaches a peak in winter, and then decreases in spring.

Orographic lifting of maritime air masses as they cross the Cascade Mountains produces a belt of heavy precipitation along the windward slope and near the crest. Warming of these air masses as they descend the lee slope results in a decrease in precipitation from nearly 100 inches at the crest of the mountains to less than 10 inches in the lower valley at the eastern edge of the county. Approximately two-thirds of the annual precipitation falls from October through March. The driest months are July and August. Summer precipitation frequently occurs as showers and is associated with thunderstorm activity over the mountains. Occasionally, heavy showers in the mountains produce flash floods at the mouth of narrow canyons.

By EARL PHILLIPS, climatologist for Washington, National Weather Service, U.S. Department of Commerce.

Most winter precipitation falls as snow. In the mountains, snow can be expected in October. It reaches the lower valleys by the end of November. Snowfall in winter ranges from 30 to 50 inches in the lower valleys near the eastern edge of the county, from 100 to 200 inches in Chiwawa and Wenatchee River Valleys and on the lower slopes of the mountains, and from 300 to 500 inches on the higher slopes and near the crest of the Cascades. The snowpack in the mountains reaches depth of 10 to 20 feet in March and has a density of about 40 percent water.

In the lower valleys, afternoon temperatures during the warmest summer months range from 80° to 90° F. Maximum temperatures reach 95° or higher on 10 to 15 days and 100° on a few afternoons. In the mountains, temperatures can be expected to decrease 3° to 4° with each 1,000 feet of increase in altitude. Minimum temperatures are in the fifties and sixties in the valleys and in the forties in the mountains.

In winter, weather systems moving eastward from over the Pacific, combined with outbreaks of cold air from Canada, produce frequent changes. Afternoon temperatures range from 25° to 35° and minimum temperatures from 15° to 25°. Maximum temperatures are below freezing on 15 to 25 days and minimum temperatures are below freezing most nights from mid-November to mid-March. Temperatures drop to 20° on 30 to 50 nights, to 10° on 10 to 25 nights, and to zero or lower on a few nights. The coldest weather occurs with outbreaks of cold arctic air.

Tables 9 and 10 summarize climatic data recorded at several locations in the Chelan Area for the period 1931-60.

The loss of heat by radiation at night, plus moist air reaching this Area, results in a considerable amount of cloudiness and some fog during the colder months. It is estimated that this Area receives 15 to 30 percent of the possible sunshine in winter, 30 to 60 percent in spring and in fall, and 75 to 85 percent in summer.

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All tables have been updated and are available as a separate document.

The topography of the Area has a decided influence on the wind. In general, the prevailing direction of the wind above the mountains is west of southwest most of the year. The wind direction along the lee slopes of the Cascade Mountains is influenced by the orientation of the ridges extending southeast from the main north-south range of the Cascade Mountains and the river valleys. Extreme winds can be expected to reach 50 to 60 miles per hour once in 2 years and 70 to 80 miles per hour once in 50 years. Wind velocities on exposed ridges can be expected to exceed these values.

Annual evaporation from a class A pan is estimated to be 30 to 40 inches on the higher slopes of the mountains and 50 to 60 inches in some of the lower valleys.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

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.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material

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that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizons above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Concretions. Grains, pellets, or nodules of various sizes, shapes. and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are

Loose.-Non coherent 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.

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.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by ice.

Gravel. Rounded and subrounded fragments of rocks up to 3 inches in diameter. Also refers to a mass of fragments.

Green-manure crop. A crop grown for the purpose of being turned under in an early stage of maturity or soon after maturity for soil improvement.

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 residue.

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.

Loess. Anne-grained material, dominantly of silt-sized particles, that has been deposited by wind.

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.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism. or a block, in contrast to a clod.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction ; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus

pH		*pH*	
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff ; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water. Terms used in this survey are relative, assuming a bare surface. These terms are *very slow, slow, medium, rapid,* and *very rapid.* Irrigated ratings apply to a bare soil and a constant head of water. They are relative within the soil survey area.

Slope classes. The slope classes used in this survey are *nearly level,* 0 to 3 percent slopes; *gently sloping,* 3 to S percent slopes; *strongly sloping,* 8 to 15 percent slopes; *moderately steep,* 15 to 25 percent slopes : *steep,* 25 to 45 percent slopes ; and *very steep,* more than 45 percent slopes.

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.

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.

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.

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.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."