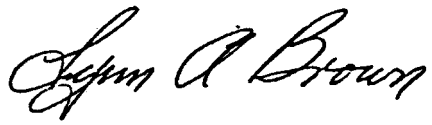
foreword

This soil survey contains information that can be used in land-planning programs in the Snohomish County Area. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.



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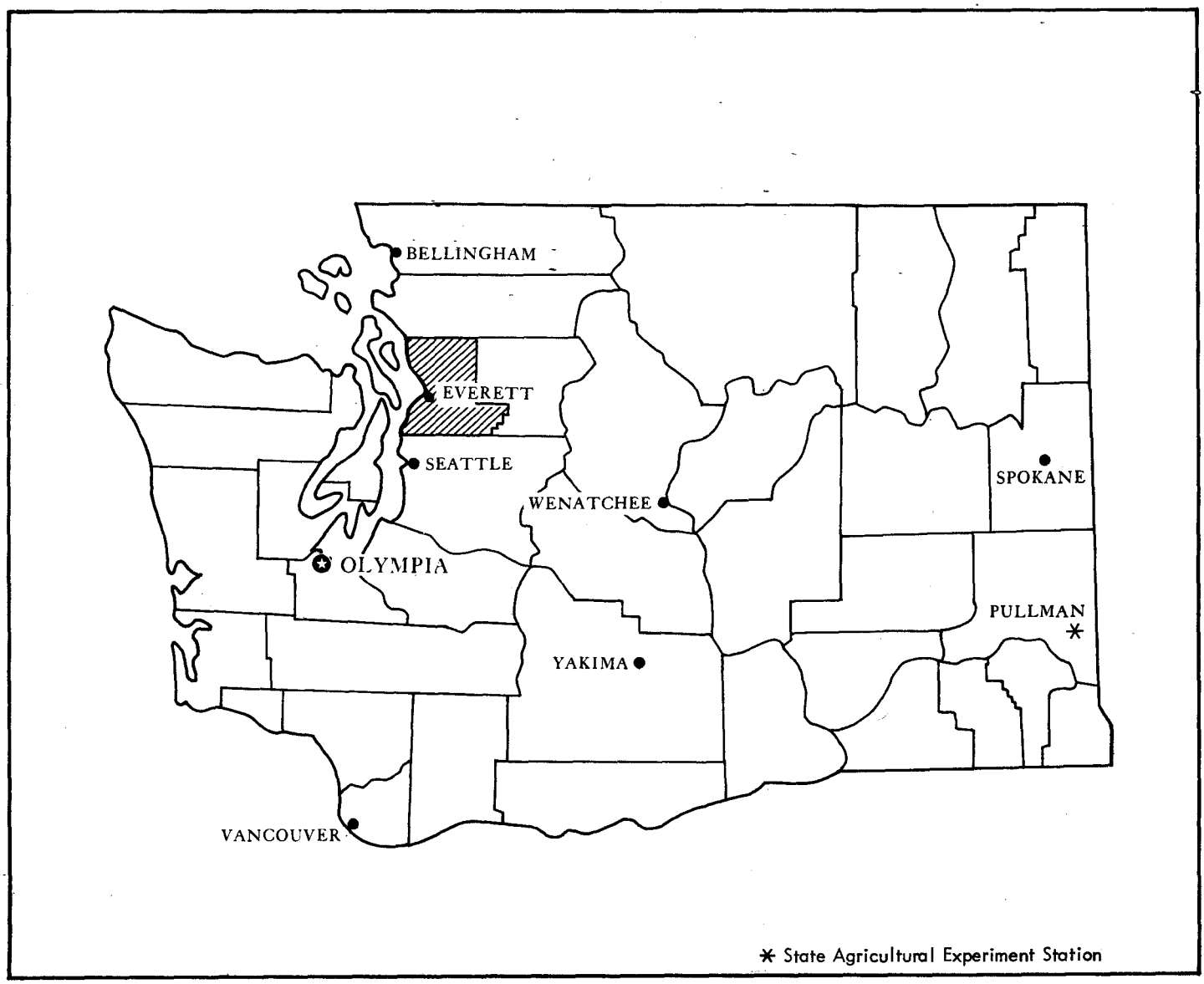

Location of Snohomish County Area in Washington.

soil survey of
Snohomish County Area, Washington

By Alfonso Debose and Michael W. Klungland, Soil Conservation Service

Fieldwork by Alfonso Debose, Jonathan P. Edwards, Michael W. Klungland, George Hartman, Dale E. Snyder, and Barry S. Strickland, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service in cooperation with
Washington State Department of Natural Resources and
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SNOHOMISH COUNTY AREA is in the northwestern part of Washington. It is in Puget Sound Basin. The total area of Snohomish County Area is 624,640 acres, or about 976 square miles (20). Everett, the county seat, has a population of 45,100.

The western part of the survey area is nearly level and rolling, benchlike glaciated plains. The eastern part is very steep mountains and narrow valleys. The Snohomish-River flows from southeast to northwest through the center of the area, and the Stillaguamish River flows from east to west through the northern part.

Lumbering and dairy farming are the main sources of income in the area. Wetness limits the area for most other uses. Specialty crops, row crops, and berries are grown in areas that are drained and protected from flooding. Commercial fishing is also an important industry in the area.

The proximity to metropolitan Seattle and the aircraft manufacturing complexes near Everett have resulted in increased urbanization of formerly rural areas of Snohomish County Area. Areas around Everett and Marysville in the west-central and southwestern parts of the county are the main parts of the survey area affected by this trend.

Soil scientists have determined that there are about 40 different kinds of soil in the survey area. The soils differ widely in texture, natural drainage, and other characteristics.

This soil survey updates an earlier survey of Snohomish County that was published in 1947 (3). It provides additional information and larger maps that show the soils in greater detail.

Descriptions, names, and delineations of soils in this survey do not fully agree with those on soils maps for adjacent counties. Differences are the result of better knowledge of soils, modifications in series concepts, intensity of mapping, or the extent of soils within the area.

general nature of the survey area

This section provides general information about the survey area. It discusses history and development, physiography and drainage, and climate.

history and development

Captain George Vancouver landed near the present site of Everett, Washington, on July 4, 1792. Native Americans, fur traders, and trappers were the main inhabitants of the area, which was dominantly controlled by the Hudson's Bay Company. A treaty in 1846 made the area part of the United States, and this opened it to other settlers.

Snohomish County was established on July 14, 1861. Mukilteo was the county seat. The county seat was moved to Snohomish in the summer of 1861 and then to Everett in 1892.

The building of the railroad led to the exploitation of timber resources in the survey area. Tracts along the rivers in the area were the main sites harvested in these early days of logging. These low-elevation, warm sites were easily accessible, had the largest and best timber, and could be logged most of the year.

The first sawmill began operating at Tulalip in 1853. Other sawmills were operated at Snohomish, Marysville, Stanwood, and Lowell in later years. Timber is still the most important industry in the area.

physiography and drainage

The physiography of the survey area is characterized by: (1) nearly level alluvial deposits along the major river valleys; (2) glacial till plains, outwash plains, and terraces in the middle part of the area; and (3) mountainous areas in the eastern part of the area.

The basic drainage flow is from the mountains in the east to the Puget Sound in the west. The North Fork of the Stillaguamish River, along the northern edge of the survey area, begins at the town of Darrington and drains into the Puget Sound. The South Fork, which is in the center of the area, begins at Granite Falls. and joins the North Fork at the town of Arlington. The Skykomish River begins at the town of Index in the southern part of the area, flows westerly through the towns of Sultan and Monroe, and joins the Snoqualmie River near the town of Snohomish to form the Snohomish River. The Snohomish River flows northwesterly through Everett to the Puget Sound.

climate

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

The climate of Snohomish County Area is greatly tempered by winds from the Pacific Ocean. Summers are fairly warm, but hot days are rare. Winters are cool, but snow and freezing temperatures are not common except at the higher elevations. During summer, rainfall is extremely light, so crops growing actively during this period need irrigation. Several weeks in summer often pass without precipitation. During the rest of the year, rains are frequent, especially late in fall and in winter.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Darrington and Everett for the period 1951-78. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperatures at Darrington and Everett are 36 and 40 degrees F, respectively. The average daily minimum temperature is 30 degrees at Darrington and 34 degrees at Everett. The lowest temperature occurred at Darrington on January 28, 1969, and is -10 degrees. In summer the average temperature is 62 degrees at both Darrington and Everett. The average daily maximum temperature is about 72 degrees. The highest recorded temperature, which occurred at Darrington on July 12, 1951, is 103 degrees.

Growing degree days, shown in table 1, are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 83 inches at Darrington and 36 inches at Everett. Of this, 20 to 30 percent usually falls in April through September, which includes the growing season for most crops. The heaviest 1-day rainfall during the period of record was 6.30 inches at Darrington on February 28, 1972. Thunderstorms occur on about 7 days each year, and most occur in summer.

The average seasonal snowfall is 51 inches at Darrington and 8 inches at Everett. The greatest snow depth at any one time during the period of record was 44 inches. On an average, 16 days at Darrington have at least 1 inch of snow on the ground. Everett seldom has a day with at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 85 percent. The percentage of possible sunshine is 65 in summer and 25 in winter. The prevailing wind is from the southwest. Average windspeed is highest, 10 miles per hour, in winter.

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

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study 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, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the

boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The six map units in this survey are described in the following pages.

1. Puget-Sultan-Pilchuck

Very deep, poorly drained, moderately well drained, and somewhat excessively drained, nearly level soils; on flood plains

This map unit is on flood plains along the major streams in the northern, central, and southern parts of the survey area. Slope is 0 to 3 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 0 to 800 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

This unit makes up about 11 percent of the survey area. It is about 35 percent Puget soils, 20 percent Sultan soils, and 15 percent Pilchuck soils. The remaining 30, percent is soils of minor extent.

Puget soils are in depressional areas on flood plains. These soils are very deep and poorly drained. They formed in alluvium. The soils are silty clay loam to a depth of 60 inches or more.

Sultan soils are on flood plains. These soils are very deep and moderately well drained. They formed in alluvium. The surface layer is silt loam. The next layer is silty clay loam. Below this to a depth of 60 inches or more is stratified very fine sandy loam and sand.

Pilchuck soils are on flood plains. These soils are very deep and somewhat excessively drained. They formed in alluvium. The surface layer is loamy sand. The underlying material to a depth of 60 inches or more is fine sandy loam and fine sand over gravelly sand.

Of minor extent in this unit are well drained Puyallup soils, poorly drained Snohomish soils, and Sumas soils.

This unit is used mainly as cropland, for hay and pasture, and for urban development. It is also used for production of timber, mainly hardwoods.

The main limitation for cultivated crops and for hay and pasture is the seasonal high water table in areas that are not adequately drained.

The main limitations for urban development are seasonal flooding and soil wetness.

2. Norma-Lynnwood-Custer

Very deep, poorly drained and somewhat excessively drained, nearly level to very steep soils; on outwash plains and terraces and in basins and depressional areas on outwash plains and till plains

This map unit is in the north-central part of the survey area. Slope is 0 to 90 percent. The vegetation is mainly conifers and hardwoods. Elevation is near sea level to 600 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

This unit makes up about 6 percent of the survey area. It is about 40 percent Norma soils, 20 percent Lynnwood soils, and 10 percent Custer soils. The remaining 30 percent is soils of minor extent.

Norma soils are in depressional areas on outwash plains and till plains. These soils are very deep and poorly drained. They formed in alluvium. The surface layer is loam. The subsoil and substratum to a depth of 60 inches or more are sandy loam.

Lynnwood soils are on terraces, terrace escarpments, and outwash plains. These soils are very deep and somewhat excessively drained. They formed in glacial outwash. The surface is covered with a mat of leaves, needles, and twigs. The surface layer and subsoil are loamy sand. The substratum to a depth of 60 inches or more is sand.

Custer soils are in basins on outwash plains. These soils are very deep and poorly drained. They formed in glacial outwash. The surface layer is fine sandy loam. The upper part of the subsoil is loamy fine sand, and the lower part is sand and has a discontinuous, iron-

cemented hardpan. The substratum to a depth of 60 inches or more is fine sand over gravelly coarse sand.

Of minor extent in this unit are Norma Variant soils, well drained Ragnar soils, and very poorly drained Orcas soils.

This unit is used as cropland and for hay and pasture, woodland, and urban development.

The main limitation for cultivated crops and for hay and pasture is the seasonal high water table in areas that are not adequately drained.

The main limitations of this unit for urban development are soil wetness, ponding, and steepness of slope. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

3. Alderwood-Everett

Moderately deep and very deep, moderately well drained and somewhat excessively drained, nearly level to very steep soils; on till plains, terraces, and outwash plains

This map unit is adjacent to Puget Sound, along the western edge of the survey area. Slope is 0 to 70 percent. The vegetation is mainly conifers. Elevation is near sea level to 550 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

The unit makes up about 37 percent of the survey area. It is about 60 percent Alderwood soils and 10 percent Everett soils. The remaining 30 percent is soils of minor extent.

Alderwood soils are on till plains. These soils are moderately deep and moderately well drained. They formed in glacial till. The surface layer is gravelly sandy loam. The subsoil is very gravelly sandy loam. A weakly cemented hardpan is at a depth of about 35 inches. Depth to the hardpan ranges from 20 to 40 inches.

Everett soils are on terraces and outwash plains. These soils are very deep and somewhat excessively drained. They formed in glacial outwash. The surface layer is gravelly sandy loam. The subsoil is very gravelly sandy loam. The substratum to a depth of 60 inches or more is very gravelly loamy sand over extremely gravelly sand.

Of minor extent in this unit are moderately well drained Kitsap soils; poorly drained McKenna, Norma, and Bellingham soils; very poorly drained Mukilteo soils and Terric Medisaprists; well drained Ragnar soils; and somewhat excessively drained Indianola soils.

This unit is used as woodland and for urban development and hay and pasture.

The main limitations of this unit for urban development are seasonal soil wetness, depth to the hardpan, and steepness of slope. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

The main limitations for hay and pasture are the depth to the hardpan and low available water capacity.

4. Tokul-Pastik

Moderately deep and very deep, moderately well drained, nearly level to very steep soils; on till plains and terraces

This map unit is in the central, northern, and southern parts of the survey area. Slope is 0 to 50 percent. The vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

This unit makes up about 28 percent of the survey area. It is about 55 percent Tokul soils and 10 percent Pastik soils. The remaining 35 percent is soils of minor extent.

Tokul soils are on till plains. These soils are moderately deep and moderately well drained. They formed in glacial till and volcanic ash. The surface is covered with a mat of partially decomposed litter. The surface layer and subsoil are gravelly loam. The substratum is gravelly fine sandy loam. A hardpan is at a depth of about 31 inches.

Pastik soils are on terraces. These soils are very deep and moderately well drained. They formed in lake sediment and volcanic ash. The soils to a depth of 60 inches or more are silt loam.

Of minor extent in this unit are Ogarty soils, poorly drained McKenna soils, very poorly drained Mukilteo soils and Terric Medisaprists, somewhat excessively drained Winston soils, and well drained Nargar soils.

This unit is used mainly as woodland. It is also used for hay and pasture and urban development.

The main limitations for hay and pasture are seasonal soil wetness, depth to the hardpan, and slope.

The main limitations for urban development are steepness of slope, wetness, and depth to the hardpan.

5. Elwell-Olomount-Skykomish

Very deep and moderately deep, somewhat excessively drained and moderately well drained, nearly level to very steep soils; on mountainsides, ridgetops, terraces, and outwash plains

This map unit is in the mountainous eastern part of the survey area. Slope is 3 to 90 percent. The vegetation is mainly conifers. Elevation is 400 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 85 to 150 days.

This unit makes up about 13 percent of the survey area. It is about 45 percent Elwell soils, 20 percent Olomount soils, and 15 percent Skykomish soils. The remaining 20 percent is components of minor extent. Elwell soils are on mountainsides and ridgetops. These soils are moderately deep and moderately well

drained. They formed in glacial till and volcanic ash. The surface is covered with a mat of partially decomposed litter. The surface layer and subsoil are silt loam. The substratum is gravelly fine sandy loam. A weakly cemented hardpan is at a depth of about 27 inches.

Olomount soils are on mountainsides and ridgetops. These soils are moderately deep and moderately well drained. They formed in glacial till, volcanic ash, and material derived from andesite, argillite, and basalt. The surface is covered with a mat of partially decomposed litter. The surface layer and subsoil are gravelly loam. The substratum is very gravelly loam and extremely gravelly loam. Andesite is at a depth of about 32 inches.

Skykomish soils are on terraces and outwash plains. These soils are very deep and somewhat excessively drained. They formed in glacial outwash and volcanic ash. The surface is covered with a mat of partially decomposed litter. The surface layer is gravelly loam. The subsoil is gravelly loam and very gravelly fine sandy loam. The substratum to a depth of 60 inches or more is extremely gravelly loamy coarse sand and extremely gravelly coarse sand.

Of minor extent-in this, unit are Rober soils, well drained Nargar Variant soils, and Rock outcrop.

This unit is used mainly as woodland, watershed, and wildlife habitat.

The main limitation for the harvesting of timber is seasonal soil wetness and steepness of slope.

6. Getchell-Oso

Moderately deep, moderately well drained, nearly level to very steep soils; on mountainsides and ridgetops

This map unit is at the mountainous northern and southern edges of the survey area. Slope is 3 to 90 percent. The vegetation is mainly conifers. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 90 to 125 days.

This unit makes up about 5 percent of the survey area. It is about 40 percent Getchell soils and 20 percent Oso soils. The remaining 40 percent is components of minor extent (fig. 1).

Getchell soils are on mountainsides and ridgetops. These soils are moderately deep and moderately well drained. They formed in glacial till and volcanic ash. The surface is covered with a mat of partially decomposed litter. The surface layer and subsoil are silt loam. Dense glacial till is at a depth of about 36 inches.

Oso soils are on mountainsides and ridgetops. These soils are moderately deep and moderately well drained.

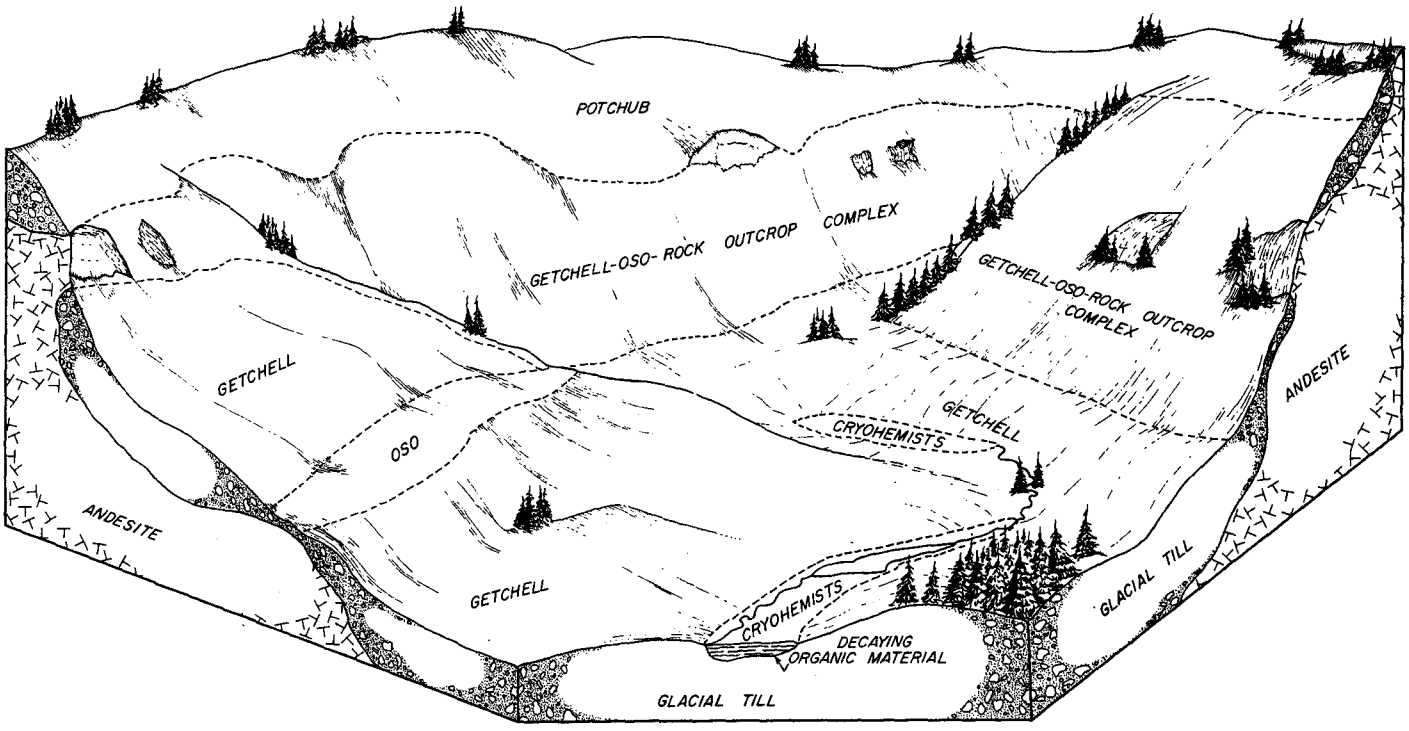

Figure 1.-Typical pattern of soils in the Getchell-Oso general map unit

They formed in glacial till, volcanic ash, and material derived dominantly from andesite. The surface is covered with a mat of leaves, needles, twigs, and moss. The soils are gravelly loam throughout. Andesite is at a depth of about 29 inches.

Of minor extent in this unit are Hartnit, Potchub, and Verlot soils, very poorly drained Cryohemists, and Rock outcrop.

This unit is used as woodland, watershed, and wildlife habitat.

The main limitation for the harvesting of timber is seasonal soil wetness and steepness of slope.

broad land use considerations

The population of Snohomish County Area has increased 21 percent in the last 10 years. This has resulted in increased demands on the area's natural resources. Each year for the last 5 years, about 1,000 acres of woodland and pasture has been converted to urban development. The general soil map in this survey is helpful for general planning of urban areas, but it cannot be used to determine the suitability of a specific site for a given use.

About 11 percent of the survey area is soils on flood plains. These soils are mainly in general soil map unit 1. They are severely limited for urban development, woodland, and most other uses by the hazards of flooding and ponding. Protection from flooding and drainage are needed to overcome these limitations. Row crops and other specialty crops are well suited to these soils and to some nearly level areas of unit 2 that are on outwash terraces.

Urban land, consisting of small areas of general soil map unit 1 and parts of units 3 and 4, makes up about 15 percent of the area. About 70 percent of the survey area is woodland, which includes units 5 and 6 and parts of units 3 and 4. General soil map unit 2 is well suited to parks and other recreational development. Units 3, 4, 5, and 6 are also suited to recreation; however, recreational development is not economically feasible. Trees enhance the beauty of areas of these units, and the marshes and swamps are suitable for use as nature study areas. All areas provide habitat for many species of wildlife.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up *a soil series.* Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alderwood gravelly sandy loam, 2 to 8 percent slopes, is one of several phases in the Alderwood series.

Some map units are made up of two or more major soils. These map units are called soil complexes.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Getchell-Oso complex, 15 to 30 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Pits is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

map unit descriptions

1-Alderwood gravelly sandy loam, 2 to 8 percent slopes. This moderately well drained soil is on till plains. It is moderately deep over a hardpan. The soil formed in glacial till. Areas are irregular in shape. They are about 100 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 550 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

Typically, the surface layer is very dark grayish brown gravelly sandy loam about 7 inches thick. The upper part of the subsoil is dark yellowish brown and dark brown very gravelly sandy loam about 23 inches thick. The lower part is olive brown very gravelly sandy loam about 5 inches thick. A weakly cemented hardpan is at a depth of about 35 inches. Depth to the hardpan ranges from 20 to 40 inches.

Included in this unit are small areas of soils that have a stony or bouldery surface layer and areas of McKenna soils, Norma soils, and Terric Medisaprists in drainageways on plains. Also included are small areas of Everett, Indianola, and Ragnar soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Alderwood soil is moderately rapid above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A seasonal perched water table is at a depth of 18 to 36 inches from January to March.

This unit is used mainly for urban development and as woodland. It is also used for hay and pasture.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site

index is 142. On the basis of a 50-year site curve, the mean site index is 108. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 148 cubic feet per acre. Among the trees of limited extent are western redcedar, western hemlock, and red alder. Among the common forest understory plants are salal, evergreen huckleberry, Oregon-grape, brackenfern, and western swordfern.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit, but gravel is available in areas of adjacent Everett soils. Brush competition is the main limitation for the production of timber.

Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent the establishment of seedlings. Because the rooting depth is restricted by a cemented pan, trees are subject to windthrow.

This unit is suited to hay and pasture. The main limitations are the low available water capacity and the weakly cemented hardpan, which limits the use of the soil in this unit for deep-rooted plants. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff.

Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion. Periodic mowing and spreading of the droppings help to maintain uniform growth, discourage selective grazing, and reduce clumpy growth.

Proper grazing practices and weed control are needed for maximum quality of forage. In some years, supplemental irrigation is also needed. Fertilizer is needed for optimum growth of grasses and legumes.

The main limitations for homesites and septic tank absorption fields are the depth to the weakly cemented hardpan and wetness. Drainage needs to be provided if buildings with basements and crawl spaces are constructed. Onsite waste disposal systems often fail or do not function properly during periods of high rainfall. The soil in this unit has an inherent ability to support large loads. Topsoil needs to be stockpiled during site preparation and subsequently used to cover the exposed underlying material.

This map unit is in capability subclass IVe.

2-Alderwood gravelly sandy loam, 8 to 15 percent slopes. This moderately well drained soil is on till plains. It is moderately deep over a hardpan. The soil formed in glacial till. Areas are long and narrow. They are about 125 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 550 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

Typically, the surface layer is very dark grayish brown gravelly sandy loam about 7 inches thick. The upper part of the subsoil is dark yellowish brown and dark brown very gravelly sandy loam about 23 inches thick. The lower part is olive brown very gravelly sandy loam about 5 inches thick. A weakly cemented hardpan is at a depth of about 35 inches. Depth to the hardpan ranges from 20 to 40 inches.

Included in this unit are small areas of Everett, Indianola, and Kitsap soils on terraces and uplands. Also included are small areas of Alderwood gravelly sandy loam, 2 to 8 percent slopes. Included areas make up about 15 percent of the total acreage.

Permeability of this Alderwood soil is moderately rapid above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A seasonal perched water table is at a depth of 18 to 36 inches from January to March.

This unit is used mainly as woodland. It is also used for hay and pasture and for urban development.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 142. On the basis of a 50-year site curve, the mean site index is 108. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 148 cubic feet per acre. Among the trees of limited extent are western redcedar, western hemlock, and red alder. Among the common forest understory plants are salal, evergreen huckleberry, Oregon-grape, brackenfern, and western swordfern.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Brush competition is the main limitation for the production of timber.

Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent the establishment of seedlings. Because the rooting depth is restricted by a cemented pan, trees are subject to windthrow.

This unit is suited to hay and pasture. The main limitations are slope and the weakly cemented hardpan, which limits the use of the soil in this unit for deep-rooted plants. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff.

Rotation grazing helps to maintain the quality of forage. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion. Periodic mowing and clipping help to maintain uniform growth, discourage selective grazing, and reduce clumpy growth.

Proper grazing practices and weed control are needed for maximum quality of forage. In some years,

supplemental irrigation is also needed. Fertilizer is needed for optimum growth of grasses and legumes.

The main limitations for homesites and septic tank absorption fields are the depth to the weakly cemented hardpan and wetness because of the seasonal high water table. Effluent from absorption fields flows laterally above the hardpan and may seep at the bottom of slopes. Drainage is needed if buildings with basements and crawl spaces are constructed. During construction, disturbed areas need to be seeded and runoff controlled to protect the soil from erosion. Temporary sediment basins can be used in construction areas to reduce the amount of sediment in runoff water.

This map unit is in capability subclass IVe.

3-Alderwood gravelly sandy loam, 15 to 25 percent slopes. This moderately well drained soil is on till plains. It is moderately deep over a hardpan. The soil formed in glacial till. Areas are long and narrow, are oriented in a northwest to southeast direction, and are 20 to 100 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 550 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

Typically, the surface layer is very dark grayish brown gravelly sandy loam about 7 inches thick. The upper part of the subsoil is dark yellowish brown and dark brown very gravelly sandy loam about 23 inches thick. The lower part is olive brown very gravelly sandy loam about 5 inches thick. A weakly cemented hardpan is at a depth of about 35 inches. Depth to the hardpan ranges from 20 to 40 inches.

Included in this unit are small areas of soils that are similar to this Alderwood soil but have cobbles or stones on the surface. Also included are small areas of Everett, Indianola, and Ragnar soils on terraces and eskers. Included areas make up about 15 percent of the total acreage.

Permeability of this Alderwood soil is moderately rapid above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A seasonal perched water table is at a depth of 18 to 36 inches from January to March.

This unit is used as woodland and for urban development.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 142. On the basis of a 50-year site curve, the mean site index is 108. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 148 cubic feet per acre. Among the trees of limited extent are western redcedar, western hemlock, and red alder. Among the common forest understory plants are salal, evergreen huckleberry, Oregon-grape, brackenfern, and western swordfern.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent the establishment of seedlings. Because the rooting depth is restricted by a cemented pan, trees are subject to windthrow.

The main limitations for homesites and septic tank absorption fields are the steepness of slope, depth to the weakly cemented hardpan, and wetness because of the seasonal perched water table. Effluent from absorption fields flows laterally above the pan and can seep at the bottom of slopes. Drainage is needed if buildings with basements and crawl spaces are constructed. During construction, disturbed areas need to be seeded and runoff controlled to protect the soil from erosion. Temporary sediment basins can be used to reduce the amount of sediment in the runoff water. The topsoil needs to be stockpiled during excavation and subsequently used to cover the exposed material. A site preparation system that controls runoff and maintains the esthetic value of the site is needed.

This map unit is in capability subclass IVe.

4-Alderwood-Everett gravelly sandy loams, 25 to 70 percent slopes. This map unit is on till plains, terraces, and outwash plains. Areas are 30 to 160 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is near sea level to 550 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

This unit is about 60 percent Alderwood gravelly sandy loam and about 25 percent Everett gravelly sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Ragnar, Indianola, McKenna, and Norma soils and Terric Medisaprists in depressional areas and drainageways on plains. Also included are colluvial soils, slump areas, and escarpments. Included areas make up about 15 percent of the total acreage.

The Alderwood soil is moderately deep over a hardpan and is moderately well drained. It formed in glacial till. Typically, the surface layer is very dark grayish brown gravelly sandy loam about 7 inches thick. The upper part of the subsoil is dark yellowish brown and dark brown very gravelly sandy loam about 23 inches thick. The lower part is olive brown very gravelly sandy loam about 5 inches thick. A weakly cemented hardpan is at a depth of about 35 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Alderwood soil is moderately rapid above the hardpan and very slow through it. Available

water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high. A seasonal perched water table is at a depth of 18 to 36 inches from January to March. Springs or seep areas are common.

The Everett soil is very deep and somewhat excessively drained. It formed in glacial outwash. Typically, the surface layer, where mixed to a depth of about 6 inches, is very dark grayish brown gravelly sandy loam. The subsoil is dark brown very gravelly sandy loam about 12 inches thick. The upper part of the substratum is brown very gravelly loamy sand about 5 inches thick. The lower part to a depth of 60 inches or more is dark brown extremely gravelly sand.

Permeability of the Everett soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is moderate.

This unit is used mainly as woodland and for wildlife habitat. It is also used for urban development.

Douglas-fir is the main woodland species on the Alderwood soil. On the basis of a 100-year site curve, the mean site index is 142. On the basis of a 50-year site curve, the mean site index is 108. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 146 cubic feet per acre.

Douglas-fir is the main woodland species on the Everett soil. On the basis of a 100-year site curve, the mean site index is 141. On the basis of a 50-year site curve, the mean site index is 111. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 146 cubic feet per acre.

Among the trees of limited extent on this unit are western hemlock, western redcedar, and red alder. Among the common forest understory plants are salal, evergreen huckleberry, brackenfern, red huckleberry, common rose, and Oregon-grape.

The main limitation for the harvesting of timber is steepness of slope. Slope restricts the use of wheeled and tracked equipment in skidding operations; cable yarding systems generally are safer and disturb the soils less. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling mortality is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs periodically. The high temperature and low moisture content of the Everett soil during the growing season cause high mortality of seedlings, especially those on south- and southwest-facing slopes. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings. Because the rooting depth is restricted by a cemented pan in the Alderwood soil, trees are subject to windthrow.

The main limitations of the Alderwood soil for septic tank absorption fields and homesites are steepness of slope and a seasonal perched water table. Effluent from absorption fields flows laterally above the pan and can seep at the bottom of slopes. Drainage is needed if buildings with basements and crawl spaces are constructed. This soil sloughs readily when saturated.

The main limitations of the Everett soil for septic tank absorption fields are steepness of slope and seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Road cuts tend to slough readily.

To protect the soils in this unit from erosion during construction, disturbed areas need to be seeded and runoff should be controlled.

This map unit is in capability subclass VIIe.

5-Alderwood-Urban land complex, 2 to 8 percent slopes. This map unit is on till plains. Areas are irregular in shape and are 100 to 1,000 acres in size. The native vegetation is mainly conifers. Elevation is 50 to 550 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

This unit is about 60 percent Alderwood gravelly sandy loam and about 25 percent Urban land. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of McKenna and Norma soils and Terric Medisaprists in depressional areas and drainageways on plains. Also included are small areas of soils that are very shallow over a hardpan; small areas of Everett, Indianola, and Ragnar soils on terraces and outwash plains; and soils that have a stony and bouldery surface layer. Included areas make up about 15 percent of the total acreage.

The Alderwood soil is moderately deep over a hardpan and is moderately well drained. It formed in glacial till. Typically, the surface layer is very dark grayish brown gravelly sandy loam about 7 inches thick. The upper part of the subsoil is dark yellowish brown and dark brown very gravelly sandy loam about 23 inches thick. The lower part is olive brown very gravelly sandy loam about 5 inches thick. A weakly cemented hardpan is at a depth of about 35 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Alderwood soil is moderately rapid above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion

is slight. A seasonal perched water table is at a depth of 18 to 36 inches from January to March.

Urban land is areas that are covered by streets, buildings, parking lots, and other structures that obscure or alter the soils so that identification is not possible.

The Alderwood soil in this unit is used mainly for parks, building sites, lawns, gardens, and woodland.

The main limitations of the Alderwood soil for homesites and septic tank absorption fields are the depth to the hardpan and the seasonal perched water table. Onsite waste disposal systems often fail or do not function properly during periods of high rainfall. Drainage is needed if buildings with basements and crawl spaces are constructed. Topsoil needs to be stockpiled during site preparation and subsequently used to cover the exposed material. Additions of fertilizer and peat are desirable prior to seeding grass for lawns.

This map unit is in capability subclass IVe.

6-Alderwood-Urban land complex, 8 to 15 percent slopes. This map unit is on till plains. Areas are irregular in shape and are 25 to 100 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 550 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

This unit is about 60 percent Alderwood gravelly sandy loam and about 25 percent Urban land. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Everett and Indianola soils on terraces and outwash plains, Kitsap soils on terraces and terrace escarpments, and Ragnar soils on outwash plains. Included areas make up about 15 percent of the total acreage.

The Alderwood soil is moderately deep and moderately well drained. It formed in glacial till. Typically, the surface layer is very dark grayish brown gravelly sandy loam about 7 inches thick. The upper part of the subsoil is dark yellowish brown and dark brown very gravelly sandy loam about 23 inches thick. The lower part is olive brown very gravelly sandy loam about 5 inches thick. A weakly cemented hardpan is at a depth of about 35 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Alderwood soil is moderately rapid above the hardpan and very slow through it. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A seasonal perched water table is at a depth of 18 to 36 inches from January to March.

Urban land consists of areas that are covered by streets, buildings, parking lots, and other structures that obscure or alter the soils so that identification is not possible.

The Alderwood soil in this unit is used mainly for parks, building sites, lawns, and woodland.

The main limitations of the Alderwood soil for homesites and septic tank absorption fields are the depth to the hardpan and wetness because of the seasonal perched water table. Drainage is needed if buildings with basements and crawl spaces are constructed. Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall. Topsoil needs to be stockpiled during site preparation and subsequently used to cover the exposed underlying material. Additions of fertilizer and peat are desirable prior to seeding grass for lawns.

This map unit is in capability subclass IVe.

7-Bellingham silty clay loam. This very deep, poorly drained soil is in depressional areas. It formed in alluvium and lacustrine sediment. Areas are regular in shape and are about 2 to 25 acres in size. The native vegetation is mainly grass and sedges. Elevation is 50 to 800 feet. Slope is 0 to 3 percent. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 180 days.

Typically, the surface layer is very dark gray silty clay loam about 9 inches thick. The subsoil to a depth of 60 inches or more is mottled, gray and olive silty clay.

Included in this unit are small areas of Terric Medisaprists, very poorly drained organic soils, Norma soils along upland drainageways, Kitsap and Pastik soils on terraces, and Bellingham soils that have been drained. Included areas make up about 10 percent of the total acreage.

Permeability of this Bellingham soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 0 to about 12 inches from November to June. Runoff is very slow, and the hazard of water erosion is slight. Ponding occurs from November to June.

This unit is used for pasture, woodland, urban development, and wildlife habitat.

This unit is suited to pasture if the excess water on the surface is removed. Tile drains or open ditches can be used if suitable outlets are available. Grazing when the soil in this unit is wet results in compaction of the surface layer, poor tilth, and reduced infiltration. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage.

This unit is suited to red alder. On the basis of a 50-year site curve, the mean site index is 83. The mean annual increment at culmination (CMAI) for red alder at age 40 is 89 cubic feet per acre. Among the trees of limited extent on this unit are Douglas-fir, bigleaf maple, western redcedar, and western hemlock. Among the common forest understory plants are trailing blackberry, western swordfern, thimbleberry, salmonberry, and huckleberry.

The main limitation for the harvesting of timber is soil wetness, which limits the use of equipment to dry

periods. Use of wheeled and tracked equipment when the soil' is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are sticky when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling mortality, brush competition, and the hazard of windthrow are the main concerns for the production of timber. If seed trees are present, natural reforestation of cutover areas by red alder occurs periodically. The seasonal high water table reduces root respiration, which results in high seedling mortality. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation. Because the rooting depth is restricted by the silty clay subsoil and the high water table, trees are subject to windthrow.

The main limitations for homesites are the seasonal high water table and high shrink-swell potential. If outlets are available, wetness and ponding can be reduced by installing drain tile and diverting water away from buildings. If buildings are constructed on the soil in this unit, properly designed foundations and footings help to prevent structural damage as a result of shrinking and swelling.

The main limitations for septic tank absorption fields are slow permeability and ponding. Onsite waste disposal systems fail or do not function properly.

This map unit is in capability subclass VIw.

8-Bellingham Variant mucky silty clay loam. This very deep, poorly drained soil is in drainageways. It formed in alluvium. Areas are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 650 to 1,800 feet. Slope is 0 to 3 percent. The average annual precipitation is about 60 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface is covered with a mat of decomposed grasses, leaves, and roots about 2 inches thick. The surface layer is very dark grayish brown mucky silty clay loam about 6 inches thick. The next layers are dark grayish brown, gray, and greenish gray silty clay loam and silty clay about 36 inches thick. Below this to a depth of 60 inches or more is greenish gray, stratified loamy fine sand and silty clay loam. In some areas the surface layer is silty clay loam.

Included in this unit are areas of Rober soils on mountain terraces and terrace escarpments and Elwell soils on mountain slopes and ridgetops. Also included are small areas of soils that are gravelly silty clay loam throughout. Included areas make up about 15 percent of the total acreage.

Permeability of this Bellingham Variant soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 0 to about 12 inches. Runoff is ponded to very slow, and the hazard of water erosion is slight. Frequent periods of flooding occur from October to June.

This unit is used as woodland.

Red alder is the main woodland species on this unit. On the basis of a 50-year site curve, the mean site index is 80. The mean annual increment at culmination (CMAI) for red alder at age 40 is 84 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and Sitka spruce. Among the common forest understory plants are salmonberry, vine maple, red huckleberry, skunkcabbage, and willow.

The main limitation for the harvesting of timber is seasonal soil wetness. Frequent ponding and the seasonal high water table limit the use of equipment when the soil in this unit is wet. Use of wheeled and tracked equipment when the soil is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are sticky when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling mortality, brush competition, and the hazard of windthrow are the main concerns for the production of timber. If seed trees are present, natural reforestation of cutover areas by red alder occurs periodically. A seasonal high water table reduces root respiration, which results in high seedling mortality. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation. Because the rooting depth is restricted by a seasonal high water table, trees are occasionally subject to windthrow.

The main limitations for homesites are the hazard of flooding, the seasonal high water table, and high shrink-swell potential. If buildings are constructed on the soil in this unit, properly designing foundations and footings helps to prevent structural damage as a result of shrinking and swelling. If outlets are available, wetness and ponding can be reduced by installing drain tile and diverting water away from buildings.

The main limitations for septic tank absorption fields are the hazard of flooding, ponding, and slow permeability. Onsite sewage disposal systems fail or do not function properly.

This map unit is in capability subclass VIw.

9-Cathcart loam, 3 to 15 percent slopes. This very deep, well drained soil is on foothills and mountain foot slopes. It formed in glacial drift derived from sandstone and siltstone and in volcanic ash. Areas are 80 to 200 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 1,000 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 165 to 185 days.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsoil is dark brown and yellowish brown loam and sandy loam about 27 inches thick. The substratum to a depth of 60 inches or more is olive loam. In some areas the subsoil is sandy clay loam

or clay loam. Weathered siltstone is at a depth of 40 to 60 inches in places.

Included in this unit are small areas of Tokul soils on till plains and Pastik, Winston, and Ragnar soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Cathcart soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used for cropland, hay and pasture, and urban development.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 175. On the basis of a 50-year site curve, the mean site index is 130. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and Pacific madrone. Among the common forest understory plants are western swordfern, trailing blackberry, red huckleberry, Oregon-grape, and brackenfern.

Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

The main limitation for the harvesting of timber is seasonal wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

This unit is suited to use as cropland. A suitable cropping system is one that includes 1 or 2 years of oats, 3 or 4 years of strawberries, and 5 or 6 years of grasses and legumes. Continuous cropping with vegetables, including an annual winter cover crop used as green manure, is also suitable.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Compaction of the soil can be reduced by returning crop residue to the soil and by proper timing of tillage. Tillage should be on the contour or across the slope. Crops respond to nitrogen, phosphorus, and potassium fertilizer.

This unit is suited to hay and pasture. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion. Periodic mowing and spreading of droppings help to maintain uniform growth, discourage selective grazing, and reduce clumpy growth.

Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime. In some years supplemental irrigation is also needed.

This unit is suited to urban development. The main limitation for homesites is steepness of slope. The main limitations for septic tank absorption fields are moderate permeability and slopes of more than 8 percent. Absorption lines should be placed on the contour.

This map unit is in capability subclass IIIe.

10-Cathcart loam, 15 to 25 percent slopes. This very deep, well drained soil is on foothills and mountain foot slopes. It formed in glacial drift derived from sandstone and siltstone and in volcanic ash. Areas are 40 to 100 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 1,000 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 165 to 185 days.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsoil is dark brown and yellowish brown loam and sandy loam about 27 inches thick. The substratum to a depth of 60 inches or more is olive loam. In some areas the subsoil is sandy clay loam or clay loam. Weathered siltstone is at a depth of 40 to 60 inches in places.

Included in this unit are small areas of Tokul soils on till plains and Pastik, Winston, and Ragnar soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

.Permeability of this Cathcart soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It is also used for hay and pasture and for urban development.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 175. On the basis of a 50-year site curve, the mean site index is 130. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and Pacific madrone. Among the common forest understory plants are western swordfern, trailing blackberry, red huckleberry, Oregon-grape, and brackenfern.

Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

The main limitation for the harvesting of timber is seasonal wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

The main limitation for hay and pasture is slope. Fall tillage or seeding should be on the contour or across the

slope where practical. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, poor infiltration, and excessive runoff.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices and weed control are needed for maximum quality of forage. In some years supplemental irrigation is also needed. Fertilizer is needed for optimum growth of grasses and legumes. Legumes benefit from applications of agricultural lime.

The main limitation for homesites and septic tank absorption fields is steepness of slope.

This map unit is in capability subclass IVe.

11-Cathcart loam, 25 to 50 percent slopes. This very deep, well drained soil is on foothills and mountain foot slopes. It formed in glacial drift derived from sandstone and siltstone and in volcanic ash. Areas are 50 to 200 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 1,000 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season in 165 to 185 days.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsoil is dark brown and yellowish brown loam and sandy loam about 27 inches thick. The substratum to a depth of 60 inches or more is olive loam. In some areas the subsoil is sandy clay loam or clay loam. Weathered siltstone is at a depth of 40 to 60 inches in places.

Included in this unit are small areas of Tokul soils on till plains and Pastik, Winston, and Ragnar soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Cathcart soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used mainly as woodland.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 175. On the basis of a 50-year site curve, the mean site index is 130. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and Pacific madrone. Among the common forest understory plants are western swordfern, trailing blackberry, red huckleberry, Oregon-grape, and brackenfern.

The main limitation for the harvesting of timber is steepness of slope, which restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and disturb the soil less. Unsurfaced roads and skid trails are soft when wet and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Establishing plant cover on steep road cut and fill slopes reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Brush competition is the main concern for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

The main limitation for homesites and septic tank absorption fields is steepness of slope.

This map unit is in capability subclass VIe.

12-Cryohemists, nearly level. These deep, very poorly drained soils are in depressional areas on high mountain ridgetops. The soils formed in material derived mainly from sedges and mosses. Areas are 10 to 30 acres in size. The native vegetation is mainly sedges and mosses. Elevation is 1,800 to 3,700 feet. Slope is 0 to 1 percent. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free season is 85 to 105 days.

Typically, the upper layer is dark grayish brown and very dark gray organic material about 10 inches thick. The next layer is black, very dark grayish brown and dark reddish brown organic material about 26 inches thick. Below this is light gray diatomaceous earth about 3 inches thick over grayish brown and olive gray clay loam that extends to a depth of 60 inches or more. Texture of the lower layer varies widely within short distances. Thickness of the organic material ranges from 16 inches to more than 60 inches.

Included in this unit are small areas of Getchell, Potchub, and Verlot soils on mountainsides and ridgetops. Included areas make up about 15. percent of the total acreage.

Permeability of these Cryohemists is moderately slow. Available water capacity is high. Effective rooting depth is limited by a seasonal water table that is at a depth of 0 to about 10 inches. Runoff is ponded.

This unit is used mainly for wetland wildlife habitat. It provides nesting areas for ducks, heron, and other waterfowl. Plantings of smartweed, wild millet, or bullrush encourage added populations. This unit also provides habitat for muskrats and beavers. Logging in the area may disturb the value of the unit as nesting areas for waterfowl.

This map unit is in capability subclass Vw.

13-Custer fine sandy loam. This very deep, poorly drained soil is in basins on outwash plains. It formed in glacial outwash. Areas are 15 to 40 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is near sea level to 150 feet. Slope is 0 to 2 percent. The average annual precipitation is about 40 inches, the average annual air temperature is about 50

degrees F, and the average frost-free season is 150 to 200 days.

Typically, the surface layer is very dark grayish brown fine sandy loam about 9 inches thick. The upper part of the subsoil is loamy fine sand about 7 inches thick. The lower part is gray and olive sand about 19 inches thick and has iron-cemented concretions that form a discontinuous hardpan. The substratum is gray sand about 14 inches thick over gravelly coarse sand that extends to a depth of 60 inches or more. In some areas a hardpan is not present in the subsoil.

Included in this unit are small areas of Indianola soils on terraces, Norma soils in upland drainageways, and Custer soils that have been partially drained. Included areas make up about 15 percent of the total acreage.

Permeability of this Custer soil is moderately slow in the discontinuous hardpan and very rapid below it. Available water capacity is low. Effective rooting depth is limited by a seasonal high water table that is at a depth of about 12 inches. Runoff is very slow. Ponding occurs from November to March.

This unit is used mainly for pasture and as cropland. A few areas are used as woodland.

The main limitation for pasture is wetness. Grazing when the soil in this unit is wet results in compaction of the surface layer. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and protects the soil from erosion. Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Fertilizer is needed for optimum growth of grasses and legumes.

The depth to the water table is the main limitation of the soil in this unit for crops such as strawberries. Open ditches and tile drains help to remove excess water. Chiseling or subsoiling may be needed to improve permeability and increase rooting depth. Crops may require supplemental irrigation during the growing season. The organic matter content can be maintained by using all crop residue, plowing under green manure crops, and using a suitable cropping system.

This unit is suited to use as woodland. On the basis of a 50-year site curve, the estimated mean site index for red alder is 90. The estimated mean annual increment at culmination (CMAI) for red alder at 40 years of age is 101 cubic feet per acre.

The main limitation for the harvesting of timber is wetness. The seasonal high water table limits the use of equipment when the soil in this unit is wet. Use of wheeled and tracked equipment when the soil is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

The establishment of seedlings is the main concern in the production of timber. The seasonal high water table and ponding reduce root respiration, which results in high seedling mortality. If seed trees are present, natural reforestation of cutover areas by red alder occurs rapidly. Western redcedar may also be suitable for reforestation. Because the rooting depth is restricted by the discontinuous hardpan and the seasonal high water table, trees are subject to windthrow. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation.

The main limitation for homesites is the seasonal high water table. Wetness can be reduced by installing drain tile around footings. The main limitations for septic tank absorption fields are ponding, wetness, and moderately slow permeability. If effluent penetrates below the discontinuous hardpan, seepage into the water table is also a limitation. Cutbanks on this unit are subject to caving in.

This map unit is in capability subclass IVw.

14-Elwell silt loam, 3 to 30 percent slopes. This moderately deep, moderately well drained soil is on mountainsides and ridgetops. It formed in glacial till and volcanic ash. Areas are 20 to 50 acres in size. The native vegetation is mainly conifers. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 45 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface layer is black silt loam about 2 inches thick. The subsoil is strong brown, brown, and yellowish brown silt loam about 21 inches thick. The substratum is pale olive gravelly fine sandy loam about 4 inches thick. An olive, weakly cemented hardpan is at a depth of about 27 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the hardpan is at a depth of more than 40 inches.

Included in this unit are small areas of Rober and Olomount soils on mountainsides and ridgetops and Skykomish soils on terraces. Included areas make up about 15 percent of the total acreage.

Permeability of this Elwell soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. A seasonal perched water table is at a depth of 18 to 36 inches from November to June. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland, watershed, and wildlife habitat.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 152. On the basis of a 50-year site curve, the mean site index is 108. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 241 cubic feet per acre. Among the trees of limited extent are Douglas-fir, western redcedar, Pacific silver fir, red alder, and bigleaf maple. Among the common forest

understory plants are western swordfern, red huckleberry, brackenfern, deer fern, and salal.

The main limitation for the harvesting of timber is seasonal soil wetness. Occasional snowpack hinders harvesting operations. The seasonal perched water table limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil is wet produces ruts, compacts the soil, and damages the roots of trees. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Rock for road construction is not readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation.

Because the rooting depth is restricted by a compacted layer of till, trees are subject to windthrow. Western hemlock, a shallow-rooted species, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitations for homesites are the seasonal perched water table and steepness of slope in areas where slope is more than 15 percent. Drainage is needed if buildings with basements and crawl spaces are constructed.

The main limitations for septic tank absorption fields are the depth to the hardpan, the seasonal perched water table, and steepness of slope in areas where slope is more than 15 percent.

This map unit is in capability subclass IVe.

15-Elwell-Olomount complex, 15 to 30 percent slopes. This map unit is on mountainsides and ridgetops. Areas are 100 to 400 acres in size. The native vegetation is mainly conifers. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 130 to 150 days.

This unit is about 65 percent Elwell silt loam and about 20 percent Olomount gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Rober soils on terraces and terrace escarpments, Skykomish soils on terraces and outwash plains, soils that have a hardpan at a depth of more than 40 inches, and Rock outcrop. Included areas make up about 15 percent of the total acreage.

The Elwell soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface layer is black silt loam about 2 inches thick. The subsoil is strong brown, brown, and yellowish brown silt loam about 21 inches thick. The substratum is pale olive gravelly fine sandy loam about 4 inches thick. An olive, weakly cemented hardpan is at a depth of about 27 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Elwell soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high. A seasonal perched water table is at a depth of 18 to 36 inches from November to June.

The Olomount soil is moderately deep and moderately well drained. It formed in glacial till, volcanic ash, and material derived dominantly from andesite, argillite, and basalt. Typically, the surface is covered with a mat of leaves, needles, mosses, and partially decomposed litter about 3 inches thick. The surface layer is very dark grayish brown gravelly loam about 2 inches thick. The subsoil is reddish brown and dark brown gravelly loam about 16 inches thick. The substratum is dark brown very gravelly loam and extremely gravelly loam about 14 inches thick. Andesite is at a depth of about 32 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Olomount soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high. A seasonal perched water table is at a depth of 18 to 36 inches from November to May.

This unit is used mainly as woodland, watershed, and wildlife habitat.

Western hemlock is the main woodland species on the Elwell soil. On the basis of a 100-year site curve, the mean site index is 152. On the basis of a 50-year site curve, the mean site index is 108. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 241 cubic feet per acre.

Western hemlock is also the main woodland species on the Olomount soil. On the basis of a 100-year site curve, the mean site index is 152. On the basis of a 50-year site curve, the mean site index is 112. The mean annual increment at culmination (CMAI) for western hemlock is at age 50 is 241 cubic feet per acre.

Among the trees of limited extent on this unit are Douglas-fir, western redcedar, Pacific silver fir, red alder, and bigleaf maple. The common forest understory plants are brackenfern, vine maple, deer fern, salmonberry, salal, western swordfern, and red huckleberry.

The main limitation for the harvesting of timber is seasonal soil wetness. Occasional snowpack hinders harvesting operations. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment. The seasonal perched water table limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soils in this

unit are wet produces ruts, compacts the soils, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Seedling establishment and windthrow hazard are the main concerns in the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation.

Because the rooting depth is restricted by the hardpan or bedrock, trees are occasionally subject to windthrow. Western hemlock, a shallow- rooted species, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitations for homesites and septic tank absorption fields are steepness of slope, depth to bedrock or the hardpan, and wetness. A seasonal high water table is perched above the hardpan or bedrock; therefore, drainage is needed if buildings with basements and crawl spaces are constructed. Deep cuts in the Olomount soil can expose bedrock.

This map unit is in capability subclass IVe.

16-Elwell-Olomount-Rock outcrop complex, 30 to 60 percent slopes. This map unit is on mountainsides. Areas are 100 to 400 acres in size. The native vegetation is mainly conifers. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 130 to 150 days.

This unit is about 50 percent Elwell silt loam, about 25 percent Olomount gravelly loam, and about 10 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Rober soils on terraces and terrace escarpments, Skykomish soils on terraces and outwash plains, and talus slopes below areas of Rock outcrop. Included areas make up about 15 percent of the total acreage.

The Elwell soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface layer is black silt loam about 2 inches thick. The subsoil is strong brown, brown, and yellowish brown silt loam about 21 inches thick. The substratum is pale olive gravelly fine sandy loam about 4 inches thick. An olive, weakly cemented hardpan is at a depth of about 27 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Elwell soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high. A seasonal perched water table is at a depth of 18 to 36 inches from November to June.

The Olomount soil is moderately deep and moderately well drained. It formed in glacial till, volcanic ash, and material derived dominantly from andesite, argillite, and basalt. Typically, the surface is covered with a mat of leaves, needles, mosses, and partially decomposed litter about 3 inches thick. The surface layer is very dark grayish brown gravelly loam about 2 inches thick. The subsoil is reddish brown and dark brown gravelly loam about 16 inches thick. The substratum is dark brown very gravelly loam and extremely gravelly loam about 14 inches thick. Andesite is at a depth of about 32 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Olomount soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high. A seasonal perched water table is at a depth of 18 to 36 inches from November to May.

Rock outcrop consists of areas where 90 percent of the surface is exposed, unweathered andesite, argillite, or basalt.

This unit is used mainly as woodland, watershed, and wildlife habitat.

Western hemlock is the main woodland species on the Elwell soil. On the basis of a 100-year site curve, the mean site index is 152. On the basis of a 50-year site curve, the mean site index is 108. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 241 cubic feet per acre.

Western hemlock is also the main woodland species on the Olomount soil. On the basis of a 100-year site curve, the mean site index is 152. On the basis of a 50-year site curve, the mean site index is 115. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 241 cubic feet per acre.

The areas of Rock outcrop in this unit reduce yield by about 10 percent.

Among the trees of limited extent on this unit are Douglas-fir, western redcedar, Pacific silver fir, red alder, and bigleaf maple. Among the common forest understory plants are brackenfern, vine maple, deer fern, salmonberry, and salal.

The main limitations for the harvesting of timber are steepness of slope, Rock outcrop, and seasonal soil wetness. A seasonal perched water table limits the use of equipment. Areas of Rock outcrop and occasional snowpack hinder harvesting operations. When harvesting timber, steepness of slope restricts the use of wheeled and tracked equipment in skidding operations; cable yarding systems generally are safer and disturb the soils less.

Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on

this unit. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover. Establishing plant cover on steep cut and fill slopes reduces erosion.

Seedling establishment and windthrow hazard are the main concerns in the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation. Rock outcrop limits the even distribution of reforestation.

Because the rooting depth is restricted by the hardpan or bedrock, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted species, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitations for homesites and septic tank absorption fields are steepness of slope and depth to bedrock or the hardpan. A seasonal high water table is perched above the hardpan or bedrock; therefore, drainage is needed if buildings with basements and crawl spaces are constructed. Deep cuts in-the Olomount soil can expose bedrock.

This map unit is in capability subclass VIIs.

17-Everett gravelly sandy loam, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on terraces and outwash plains. It formed in glacial outwash. Areas are long and narrow and are oriented in a northwest to southeast direction. They are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is near sea level to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

Typically, the surface layer, where mixed to a depth of about 6 inches, is dark brown gravelly sandy loam. The subsoil is dark brown very gravelly sandy loam about 12 inches thick. The upper part of the substratum is brown very gravelly loamy sand about 5 inches thick. The lower part to a depth of 60 inches or more is dark brown extremely gravelly sand. In some areas the substratum is weakly cemented.

Included in this unit are small areas of Alderwood soils on till plains, Indianola soils on terraces and outwash plains, and Ragnar soils on outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Everett soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland and for urban development. It is also used for pasture.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 141. On the basis of a 50-year site curve, the mean site index is 111. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 146 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are salal, brackenfern, red huckleberry, common rose, and Oregon-grape.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit.

Seedling mortality is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. High soil temperature and low soil moisture content during the growing season cause a high mortality of seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings.

If this unit is used for pasture, the main limitations are low available water capacity and low soil fertility. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Supplemental irrigation is also needed. Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing.

This unit is suited to urban development; however, if the density of housing is moderate to high, community sewage systems are needed in places to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass VIs.

18-Everett gravelly sandy loam, 8 to 15 percent slopes. This very deep, somewhat excessively drained soil is on terraces and outwash plains. It formed in glacial outwash. Areas are long and narrow and are oriented in a northwest to southeast direction. They are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is near sea level to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

Typically, the surface layer, where mixed to a depth of about 6 inches, is dark brown gravelly sandy loam. The subsoil is dark brown very gravelly sandy loam about 12 inches thick. The upper part of the substratum is brown very gravelly loamy sand about 5 inches thick. The lower part to a depth of 60 inches or more is dark brown extremely gravelly sand. In some areas the substratum is weakly cemented.

Included in this unit are small areas of Alderwood soils on till plains, Indianola soils on terraces and outwash plains, and Ragnar soils on outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Everett soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used for urban development and for hay and pasture.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 141. On the basis of a 50-year site curve, the mean site index is 111. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 146 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are salal, brackenfern, red huckleberry, common rose, and Oregon-grape.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit.

Seedling mortality is the main limitation in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. High soil temperature and low soil moisture content during the growing season cause a high mortality of seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings.

If this unit is used for hay and pasture, the main limitations are slope, low available water capacity, and low soil fertility. Rotation grazing, proper stocking rates, weed control, and fertilizer are needed for maximum quality of forage. Supplemental irrigation is also needed. Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Fertilizer is needed for optimum growth.

The main limitation for homesites and septic tank absorption fields is steepness of slope. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage. Septic tank absorption lines should be installed on the contour.

This map unit is in capability subclass Vls.

19-Everett gravelly sandy loam, 15 to 25 percent slopes. This very deep, somewhat excessively drained soil is on terraces and outwash plains. It formed in glacial outwash. Areas are irregular in shape and are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is near sea level to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

Typically, the surface layer, where mixed to a depth of about 6 inches, is dark brown gravelly sandy loam. The subsoil is dark brown very gravelly sandy loam about 12 inches thick. The upper part of the substratum is brown very gravelly loamy sand about 5 inches thick. The lower part to a depth of 60 inches or more is dark brown extremely gravelly sand. In some areas the substratum is weakly cemented.

Included in this unit are small areas of Alderwood soils on till plains, Indianola soils on terraces and outwash plains, and Ragnar soils on outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Everett soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It is also used for urban development.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 141. On the basis of a 50-year site curve, the mean site index is 111. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 146 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common forest understory plants are salal, brackenfern, red huckleberry, common rose, and Oregon-grape.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Seedling mortality is the main limitation in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. High soil temperature and low soil moisture content during the growing season cause a high mortality of seedlings, especially on south- and southwest-facing slopes. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings, especially on south- and southwest-facing slopes.

The main limitation for homesites and septic tank absorption fields is steepness of slope. If the density of housing is moderate or high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVe.

20-Fluvaquents, tidal. These very deep, poorly drained, salt-affected soils are on tidal flats. They formed in alluvium. Areas are 30 to 200 acres in size. The native vegetation is mainly saltgrass. Elevation is near sea level to 10 feet. Slope is 0 to 2 percent. The average annual precipitation is about 30 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 190 to 210 days.

These soils to a depth of 60 inches or more commonly are gray and light gray, stratified silt loam and silty clay loam. They range from sand to clay throughout the profile and vary widely within short distances. In some places these soils have strata of organic matter and clam shells.

Included in this unit are small areas of Mukilteo and Puget soils and Terric Medisaprists in depressional areas. Also included are several hundred acres of soils that have been diked, drained, and leached for seed crops and areas that have been diked and used as industrial sites. Included areas make up about 5 percent of the total acreage.

Permeability of Fluvaquents, tidal, is slow. Available water capacity is high. Effective rooting depth is limited

to a depth of 10 to 20 inches. Water covers these soils during high tide. Runoff is ponded.

This unit is used mainly for recreation and wildlife habitat. Clam digging and waterfowl hunting are the main recreational activities on the unit. Waterfowl such as herons and ducks use the unit as feeding and nesting areas.

This map unit is in capability subclass VIIw.

21-Getchell silt loam, 3 to 30 percent slopes. This moderately deep, moderately well drained soil is on mountainsides and ridgetops. It formed in glacial till and volcanic ash. Areas are irregular in shape and are 30 to 60 acres in size. The native vegetation is mainly conifers. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 105 to 125 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and decomposed material about 2 inches thick. The surface layer is black silt loam about 2 inches thick. The subsoil is yellowish red, strong brown, light olive brown, and dark brown silt loam about 34 inches thick. Olive, dense glacial till is at a depth of about 36 inches. Depth to glacial till ranges from 20 to 40 inches.

Included in this unit are small areas of wet organic soils. Also included are Elwell, Olomount, and Potchub soils. Included areas make up about 15 percent of the total acreage.

Permeability of this Getchell soil is moderate to the dense glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A seasonal perched water table is at a depth of 18 to 36 inches from December to May. The effect of the layer of dense glacial till on use and management is similar to that of a hardpan.

This unit is used as woodland, watershed, and wildlife habitat.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 130. On the basis of a 50-year site curve, the mean site index is 90. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 200 cubic feet per acre. Among the trees of limited extent are Pacific silver fir, Douglas-fir, and western redcedar. The common forest understory plants are red huckleberry, deer fern, brackenfern, devilsclub, and ladyfern.

The main limitation for the harvesting of timber is seasonal soil wetness. A seasonal perched water table limits the use of equipment. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Seedling establishment and windthrow hazard are the main concerns in the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings.

Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitations for homesites are the seasonal perched water table and steepness of slope in areas where slopes are more than 15 percent. Drainage is needed if buildings with basements and crawl spaces are constructed. The dense glacial till is rippable and therefore is not a serious limitation for most engineering uses.

The main limitations for septic tank absorption fields are the seasonal perched water table, depth to the dense glacial till, and steepness of slope in areas where slopes are more than 15 percent. Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall because of the restrictive layer.

This map unit is in capability subclass VIe.

22-Getchell-Oso complex, 15 to 30 percent slopes. This map unit is on mountainsides and ridgetops. Areas are irregular in shape and are 10 to 120 acres in size. The native vegetation is mainly conifers. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 90 to 125 days.

This unit is about 60 percent Getchell silt loam and about 25 percent Oso gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Elwell, Hartnit, Olomount, and Potchub soils. Also included are small areas of Skykomish soils on terraces and outwash plains and areas of Rock outcrop. Included areas make up about 15 percent of the total acreage.

The Getchell soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of needles, leaves, twigs, and decomposed material about 2 inches thick. The surface layer is black silt loam about 2 inches thick. The subsoil is yellowish red, strong brown, light olive brown, and dark brown silt loam about 34 inches thick. Olive, dense glacial till is at a depth of about 36 inches. Depth to glacial till ranges from 20 to 40 inches.

Permeability of the Getchell soil is moderate to the glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A seasonal perched water table is at a depth of 18 to 36 inches from December to May. The effect of the layer of dense glacial till on use and management is similar to that of a hardpan.

The Oso soil is moderately deep and moderately well drained. It formed in glacial till, volcanic ash, and material derived dominantly from andesite. Typically, the surface is covered with a mat of leaves, needles, twigs, and mosses about 2 inches thick. The surface layer is black gravelly loam about 3 inches thick. The subsurface layer is light brownish gray gravelly loam about 2 inches thick. The subsoil is dark brown and yellowish brown gravelly loam about 24 inches thick. Andesite is at a depth of about 29 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Oso soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A seasonal perched water table is at a depth of 18 to 36 inches from November to May.

This unit is used mainly as woodland, watershed, and wildlife habitat.

Western hemlock is the main woodland species on the Getchell soil. On the basis of a 100-year site curve, the mean site index is 130. On the basis of a 50-year site curve, the mean site index is 90. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 200 cubic feet per acre.

Western hemlock is also the main woodland species on the Oso soil. On the basis of a 100-year site curve, the mean site index is 129. On the basis of a 50-year site curve, the mean site index is 93. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 198 cubic feet per acre.

Among the trees of limited extent on this unit are Pacific silver fir, Douglas-fir, and western redcedar. Among the common forest understory plants are red huckleberry, deer fern, brackenfern, devilsclub, trailing blackberry, blue-leaved huckleberry, and bunchberry dogwood.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment. Snowpack also limits the use of equipment, and it restricts access. Use of wheeled and tracked equipment when the soils in this unit are wet produces ruts, compacts the soils, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Seedling establishment and windthrow hazard are the main concerns for the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings.

Because the rooting depth is restricted by the depth to bedrock and glacial till, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitation for homesites on the Getchell soil is the seasonal perched water table. Drainage is needed if buildings with basements and crawl spaces are constructed on it. The main limitation for septic tank absorption fields is the glacial till and wetness.

Deep cuts in the Oso soil can expose bedrock. Drainage is needed if buildings with basements and crawl spaces are constructed. Depth to rock and wetness limits the use of the soil for septic tank absorption fields.

This map unit is in capability subclass VIe.

23-Getchell-Oso-Rock outcrop complex, 30 to 65 percent slopes. This map unit is on mountainsides. Areas are irregular in shape and are 40 to 200 acres in size. The native vegetation is mainly conifers. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 90 to 125 days.

This unit is about 55 percent Getchell silt loam, about 30 percent Oso gravelly loam, and about 10 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Elwell, Hartnit, Olomount, and Potchub soils on mountainsides and ridgetops. Also included are Skykomish soils on terraces and outwash plains. Included areas make up about 5 percent of the total acreage.

The Getchell soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of needles, leaves, twigs, and decomposed material about 2 inches thick. The surface layer is black silt loam about 2 inches thick. The subsoil is yellowish red, strong brown, light olive brown, and dark brown silt loam about 34 inches thick. Olive, dense glacial till is at a depth of about 36 inches. Depth to glacial till ranges from 20 to 40 inches.

Permeability of the Getchell soil is moderate to the glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A seasonal perched water table is at a depth of 18 to 36 inches from December to May. The effect of the layer of dense glacial till on use and management is similar to that of a hardpan.

The Oso soil is moderately deep and moderately well drained. It formed in glacial till, volcanic ash, and material derived dominantly from andesite. Typically, the surface is covered with a mat of leaves, needles, twigs, and mosses about 2 inches thick. The surface layer is black gravelly loam about 3 inches thick. The subsurface layer is light brownish gray gravelly loam about 2 inches thick. The subsoil is dark brown and yellowish brown gravelly loam about 24 inches thick. Andesite is at a depth of about 29 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Oso soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A seasonal perched water table is at a depth of 18 to 36 inches from November to May.

Rock outcrop consists of areas where the surface is exposed hard andesite or argillite.

This unit is used mainly as woodland, watershed, and wildlife habitat.

Western hemlock is the main woodland species on the Getchell soil. On the basis of a 100-year site curve, the mean site index is 130. On the basis of a 50-year site curve, the mean site index is 90. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 200 cubic feet per acre.

Western hemlock is also the main woodland species on the Oso soil. On the basis of a 100-year site curve, the mean site index is 129. On the basis of a 50-year site curve, the mean site index is 93. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 198 cubic feet per acre.

Rock outcrop in this unit reduces yield by about 10 percent.

Among the trees of limited extent on this unit are Pacific silver fir, Douglas-fir, and western redcedar. Among the common forest understory plants are red huckleberry, trailing blackberry, blue-leaved huckleberry, and bunchberry dogwood.

The main limitations for the harvesting of timber are steepness of slope, seasonal soil wetness, and areas of Rock outcrop. Steepness of slope restricts the use of wheeled and tracked equipment in skidding operations; cable yarding systems generally are safer and disturb the soils less.

The seasonal perched water table limits the use of equipment. Snowpack also limits the use of equipment, and it restricts access. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Rock outcrop hinders yarding operations.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Seedling establishment and windthrow hazard are the main concerns for the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Reforestation can be accomplished by planting Douglas-fir seedlings. Rock outcrop limits the even distribution of reforestation. When openings are made in the canopy, invading brushy plants, if not controlled, can delay establishment of seedlings.

Because the rooting depth is restricted by the glacial till and underlying bedrock, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This map unit is in capability subclass VIIs.

24-Greenwater loamy sand. This very deep, somewhat excessively drained soil is on terraces. It formed in alluvium derived dominantly from andesite and pumice. Slope is 0 to 3 percent. Areas are 150 to 300 acres in size. The native vegetation is mainly conifers. Elevation is 400 to 600 feet. The average annual precipitation is about 60 inches, the average annual air temperature is 49 degrees F, and the average frost-free season is 140 to 160 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and roots about 1 inch thick. The subsurface layer is dark brown loamy sand about 2 inches thick. The subsoil is dark brown loamy sand about 19 inches thick. The substratum to a depth of 60 inches or more is dark gray sand. In some areas the surface layer is sandy loam, the soil does not contain volcanic ash, or slope is more than 3 percent.

Included in this unit are areas of Everett and Indianola soils on terraces and outwash plains and Pilchuck soils on flood plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Greenwater soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used for urban development.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 151. On the basis of a 50-year site curve, the mean site index is 116. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 159 cubic feet per acre. Among the trees of limited extent are western hemlock and red alder. The common forest understory plants are oceanspray, western brackenfern, Oregon-grape, salal, and western swordfern.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Brush competition is the main limitation for the production of timber. When openings are made in the canopy, invading brushy species, if not controlled, can

delay the establishment of seedlings. Reforestation can be accomplished by planting Douglas-fir seedlings.

This unit is suited to urban development. The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVs.

25-Hartnit-Potchub-Rock outcrop complex, 65 to 90 percent slopes. This map unit is on mountainsides. Areas are 25 to 160 acres in size. The native vegetation is mainly conifers. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free season is 90 to 100 days.

This unit is about 50 percent Hartnit gravelly silt loam, about 25 percent Potchub silt loam, and about 15 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Getchell, Oso, and Verlot soils on mountainsides and ridgetops. Also included are areas of talus below Rock outcrop. Included areas make up about 10 percent of the total acreage.

The Hartnit soil is moderately deep and moderately well drained. It formed in glacial till, volcanic ash, and material derived dominantly from andesite, argillite, and basalt. Typically, the surface is covered with a mat of leaves, needles, twigs, and decomposed material about 7 inches thick. The surface layer is black gravelly silt loam about 4 inches thick. The subsurface layer is gray gravelly silt loam about 3 inches thick. The subsoil is dark reddish brown, strong brown, and dark brown gravelly silt loam about 20 inches thick. Andesite is at a depth of about 27 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Hartnit soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

The Potchub soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of leaves, needles, twigs, and decomposed organic litter about 9 inches thick. The surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is pinkish gray silt loam about 3 inches thick. The subsoil is dark reddish brown, strong brown, and dark brown silt loam about 24 inches thick. Olive, dense glacial till is at a depth of about 34 inches. Depth to glacial till ranges from 20 to 40 inches.

Permeability of the Potchub soil is moderate above the glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high. A seasonal perched water table is at a depth of 18 to 36 inches from November to May. The effect of the layer of dense glacial till on use and management is similar to that of a hardpan.

Rock outcrop consists of areas of exposed andesite or argillite. It occurs as steep cliffs.

This unit is used mainly as woodland and watershed.

Western hemlock is the main woodland species on the Hartnit soil. On the basis of a 100-year site curve, the estimated mean site index is 60. On the basis of a 50-year site curve, the estimated mean site index is 45. The estimated mean annual increment at culmination (CMAI) for western hemlock at age 70 is 57 cubic feet per acre.

Western hemlock is also the main woodland species on the Potchub soil. On the basis of a 100-year site curve, the estimated mean site index is 68. On the basis of a 50-year site curve, the estimated mean site index is 56. The estimated mean annual increment at culmination (CMAI) for western hemlock at age 60 is 70 cubic feet per acre.

Rock outcrop in this unit reduces yield by about 15 percent.

Among the trees of limited extent are Pacific silver fir and Douglas-fir. The common forest understory plants are red huckleberry, trailing blackberry, blue-leaved huckleberry, bunchberry dogwood, and deer fern.

The main limitations for the harvesting of timber on this unit are steepness of slope and Rock outcrop. The seasonal perched water table in the Potchub soil limits the use of equipment. Snowpack also limits the use of equipment and restricts access. Cable yarding systems generally are used on the unit. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff. Rock outcrop may hinder yarding operations.

Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Establishing plant cover on steep cut and fill slopes reduces erosion.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover. Following road construction and clearcutting, road failures and landslides are likely to occur.

Seedling establishment and windthrow hazard are the main concerns in the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Rock outcrop limits the even distribution of reforestation. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings.

Because the rooting depth is restricted by the underlying bedrock in the Hartnit soil and the glacial till and seasonal perched water table in the Potchub soil, trees are subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This map unit is in capability subclass VIIe.

26-Indianola loamy sand, 15 to 25 percent slopes. This very deep, somewhat excessively drained soil is on terraces and outwash plains. It formed in sandy glacial outwash. Areas are 5 to 30 acres in size. The native vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 2 inches thick. The surface layer is very dark grayish brown loamy sand about 4 inches thick. The subsoil is dark yellowish brown loamy sand about 20 inches thick. The substratum to a depth of 60 inches or more is light olive gray and grayish brown sand.

Included in this unit are small areas of soils that have slopes of more than 25 percent. Also included are areas of Everett, Indianola, Pastik, and Ragnar soils and Custer soils in basins. Included areas make up about 15 percent of the total acreage.

Permeability of this Indianola soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland and for urban development.

Douglas-fir is the main woodland species on this unit (fig. 2). On the basis of a 100-year site curve, the mean site index is 156. On the basis of a 50-year site curve, the mean site index is 112. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 165 cubic feet per acre. Among the trees of limited extent are western redcedar, western hemlock, bigleaf maple, and red alder. The common forest understory plants are brackenfern, salal, western swordfern, trailing blackberry, and Oregon-grape.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Seedling mortality is the main limitation in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. The droughtiness of the surface layer increases seedling mortality, especially on the south- and southwest-facing slopes. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation.

The main limitation for urban development is steepness of slope. The main limitations for septic tank absorption fields are steepness of slope and seepage. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Cutbanks on the soil in this unit are subject to caving in.

This map unit is in capability subclass IVs.

Figure 2.- A young stand of Douglas-fir on Indianola loamy sand, 15 to 25 percent slopes.

27-Kitsap silt loam, 0 to 8 percent slopes. This very deep, moderately well drained soil is on terraces. It formed in lacustrine sediment. Areas are 20 to 50 acres in size. The native vegetation is mainly conifers and

hardwoods. Elevation is near sea level to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The upper part of the subsoil is dark brown silt loam about 14 inches thick. The lower part is olive brown silt loam about 13 inches thick. The substratum to a depth of 60 inches or more is light olive brown silty clay loam.

Included in this unit are small areas of soils that have a surface layer and subsoil of fine sandy loam and loamy sand. Also included are Alderwood soils on till plains, Bellingham soils in depressional areas, and Ragnar soils on outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Kitsap soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 30 inches from December to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland and for hay and pasture, cropland, and urban development.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 166. On the basis of a 50-year site curve, the main site index is 123. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 177 cubic feet per acre. Among the trees of limited extent are red alder, western redcedar, and western hemlock. Among the common forest understory plants are western swordfern, salal, Oregon-grape, trailing blackberry, and evergreen huckleberry.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet and are impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent the establishment of seedlings. Because the rooting depth is restricted by a seasonal perched water table, trees are frequently subject to windthrow. Wide spacing of trees in very young stands reduces windthrow.

This unit is well suited to hay and pasture. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion. Periodic mowing and spreading of droppings help to maintain uniform growth, discourage selective grazing, and reduce clumpy growth. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime.

This unit is well suited to row crops. The perched water table that develops during the rainy period in winter generally limits the suitability of the unit for deep-rooted crops. Tile drainage can be used to lower the water table if a suitable outlet is available. Subsoiling increases ease of root penetration.

A suitable cropping system is one that includes 1 or 2 years of oats, 3 or 4 years of strawberries, and 3 to 5 years of grasses and legumes. Annual cropping with vegetables and growing a winter cover crop that is used as green manure is also a suitable cropping system.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Crusting of the surface and compaction of the soil can be reduced by returning crop residue to the soil and by using minimum tillage. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

The main limitation for urban development is the seasonal perched water table. Drainage is needed if buildings with basements and crawl spaces are constructed. The main limitations for septic tank absorption fields are the seasonal perched water table and slow permeability. Conventional septic tank absorption fields often fail or do not function properly.

This map unit is in capability subclass IIe.

28-Kitsap silt loam, 8-to 25 percent slopes. This very deep, moderately well drained soil is on terrace escarpments. It formed in lacustrine sediment. Areas are 20 to 50 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is near sea level to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The upper part of the subsoil is dark brown silt loam about 14 inches thick. The lower part is olive brown silty clay loam about 13 inches thick. The substratum to a depth of 60 inches or more is light olive brown silty clay loam. In some areas the surface layer and subsoil are fine sandy loam and loamy sand.

Included in this unit are small areas of Alderwood soils on till plains and Everett and Ragnar soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Kitsap soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 30 inches from December to May. Runoff is medium, and the hazard of water erosion is moderate. The soil is subject to hillside slippage.

This unit is used as woodland and for hay and pasture, cropland, and urban development.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 166. On the basis of a 50-year site curve, the mean site index is 123. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 177 cubic feet per acre. Among the trees of limited extent are red alder, western redcedar, and western hemlock. Among the common forest understory plants are western swordfern, salal, Oregon-grape, trailing blackberry, and evergreen huckleberry.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they are impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent the establishment of seedlings. Because the rooting depth is restricted by a seasonal perched water table, trees are frequently subject to windthrow. Wide spacing of trees in very young stands will help reduce windthrow.

This unit is suited to hay and pasture. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion. Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime.

This unit is suited to use as cropland. Steepness of slope is the main limitation. The seasonal perched water table that develops during the rainy period in winter generally limits the suitability of the unit for deep-rooted plants. Tile drainage can be used to lower the water table if a suitable outlet is available.

A suitable cropping system is one that includes 1 or 2 years of oats and 3 to 5 years of grasses and legumes. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Crusting of the surface and compaction of the soil can be reduced by returning crop residue to the soil and by using minimum tillage. Tillage should be on the contour or across the slope. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

The main limitations for building sites are the hazard of hillside slippage and seasonal soil wetness. Steepness of slope is a limitation in areas where slopes are more than 15 percent. Drainage is needed if buildings with basements and crawl spaces are constructed. The soil in this unit may slump readily in excavated areas.

The main limitations for septic tank absorption fields are the seasonal perched water table, slow permeability, and steepness of slope in areas where slopes are more than 15 percent. Conventional septic tank absorption fields often fail or do not function properly.

This map unit is in capability subclass IIIe.

29-Kitsap silt loam, 25 to 50 percent slopes. This very deep, moderately well drained soil is on terrace escarpments. It formed in lacustrine sediment. Areas are 10 to 50 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is near sea level to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The upper part of the subsoil is dark brown silt loam about 14 inches thick. The lower part is olive brown silty clay loam about 13 inches thick. The substratum to a depth of 60 inches or more is light olive brown silty clay loam. In some areas the surface layer and subsoil are fine sand and loamy sand.

Included in this unit are small areas of Alderwood soils on till plains and Everett and Ragnar soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Kitsap soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 30 inches from December to May. Runoff is rapid, and the hazard of water erosion is high. The soil is subject to hillside slippage. Seep areas or springs are common.

This unit is used as woodland and open space in urban areas.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 166. On the basis of a 50-year site curve, the mean site index is 123. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 177 cubic feet per acre. Among the trees of limited extent are red alder, western redcedar, and western hemlock. Among the common forest understory plants are western swordfern, salal, Oregon-grape, trailing blackberry, and evergreen huckleberry.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. The steep slopes restrict the use of wheeled and tracked equipment in skidding operations.

Unsurfaced roads and skid trails are soft when wet, and they are impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Establishing plant cover on steep road cut and fill slopes reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover. Following road construction and harvesting, road failure and landslides are likely. Because the rooting depth is restricted by a seasonal perched water table, trees are frequently subject to windthrow.

Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent the establishment of seedlings.

The main limitations for building sites are steepness of slope, the hazard of hillside slippage, and soil wetness. Drainage is needed if buildings with basements and crawl spaces are constructed. Access roads must be designed to control surface runoff and help stabilize cut slopes. The soil in this unit may slump readily in excavated areas.

The main limitations for septic tank absorption fields are the seasonal perched water table, slow permeability, and steepness of slope. Conventional septic tank absorption fields often fail or do not function properly.

This map unit is in capability subclass VIe.

30-Lynnwood loamy sand, 0 to 3 percent slopes. This very deep, somewhat excessively drained soil is on terraces and outwash plains. It formed in glacial outwash. Areas generally are 10 to 30 acres in size, but a few areas are as much as 600 acres. The native vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 180 to 200 days.

Typically, the surface is covered with a mat of leaves, needles, and twigs about 3 inches thick. The surface layer is grayish brown loamy sand about 1 inch thick. The upper part of the subsoil is dark brown loamy sand about 14 inches thick. The lower part is dark yellowish brown loamy sand about 14 inches thick. The substratum to a depth of 60 inches or more is grayish brown sand. In some areas the surface layer and subsoil are sandy loam.

Included in this unit are small areas of Everett, Indianola, Pastik, and Ragnar soils. Also included are Custer soils in basins and soils that have slopes of more than 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability of this Lynnwood soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland and for urban development. It is also used for hay and pasture.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 158. On the basis of a 50-year site curve, the mean site index is 121. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 168 cubic feet per acre. Among the trees of limited extent are western hemlock and western redcedar. Among the common forest understory plants are western swordfern, brackenfern, deer fern, and red huckleberry.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Reforestation can be accomplished by planting Douglas-fir seedlings. The droughtiness of the surface layer reduces the survival of seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings.

The main limitation for hay and pasture is low available water capacity. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. In most years supplemental irrigation is needed. Fertilizer is needed for optimum growth of grasses and legumes.

This unit is suited to use as homesites. The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IVs.

31-Lynnwood-Nargar complex, 65 to 90 percent slopes. This map unit is on terrace escarpments. Areas are irregular in shape and are 20 to 200 acres in size. The native vegetation is mainly conifers. Elevation is 400 to 1,200 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 140 to 190 days.

This unit is about 60 percent Lynnwood loamy sand and about 25 percent Nargar fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Pastik, Everett, Skykomish, and Winston soils on terraces and outwash plains and soils that have a gravelly sandy loam surface layer. Included areas make up about 15 percent of the total acreage.

The Lynnwood soil is very deep and somewhat excessively drained. It formed in glacial outwash. Typically, the surface is covered with a mat of leaves, needles, and twigs about 3 inches thick. The surface

layer is grayish brown loamy sand about 1 inch thick. The upper part of the subsoil is dark brown loamy sand about 14 inches thick. The lower part is dark yellowish brown loamy sand about 14 inches thick. The substratum to a depth of 60 inches or more is grayish brown sand.

Permeability of the Lynnwood soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

The Nargar soil is very deep and well drained. It formed in sandy alluvium and volcanic ash. Typically, the surface is covered with a mat of needles, leaves, twigs, and partially decomposed litter about 1 inch thick. The surface layer, where mixed to a depth of about 6 inches, is yellowish red fine sandy loam. The subsoil is yellowish red, brown, and dark yellowish brown fine sandy loam about 20 inches thick. The upper part of the substratum is olive gray, stratified fine sand to coarse sand about 15 inches thick. The lower part to a depth of 60 inches or more is light olive brown and olive gray very gravelly loamy sand.

Permeability of the Nargar soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used mainly as woodland and for wildlife habitat.

Douglas-fir is the main woodland species on the Lynnwood soil. On the basis of a 100-year site curve, the mean site index is 158. On the basis of a 50-year site curve, the mean site index is 121. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 168 cubic feet per acre.

Douglas-fir is also the main woodland species on the Nargar soil. On the basis of a 100-year site curve, the mean site index is 185. On the basis of a 50-year site curve, the mean site index is 138. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 195 cubic feet per acre.

Among the trees of limited extent on this unit are western hemlock and western redcedar. Red alder is of limited extent on the Nargar soil. Among the common forest understory plants are western swordfern, brackenfern, ladyfern, deer fern, red huckleberry, vine maple, and salal.

The main limitation for the harvesting of timber is steepness of slope. Cable yarding systems generally are used on this unit. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Establishing plant cover on steep road cut and fill slopes reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover. Following road construction and clearcutting, road failures and landslides are likely to occur.

Brush competition is the main limitation in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of red alder occurs readily and natural reforestation of western hemlock occurs periodically on the Nargar soil. The droughtiness of the surface layer of the Lynnwood soil reduces the survival of seedlings, especially on south- and southwest-facing slopes. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent the establishment of seedlings on the Nargar soil and delay establishment on the Lynnwood soil.

This map unit is in capability subclass VIIe.

32-McKenna gravelly silt loam, 0 to 8 percent slopes. This moderately deep, poorly drained soil is in depressional areas and drainageways on till plains. It formed in glacial till. The native vegetation is mainly conifers. Elevation is 100 to 800 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 180 days.

Typically, the surface layer is very dark grayish brown gravelly silt loam about 8 inches thick. The subsoil is brown and light olive brown gravelly silt loam about 25 inches thick. Olive, compact glacial till is at a depth of 33 inches. Depth to glacial till ranges from 20 to 40 inches.

Included in this unit are small areas of soils that have slopes of more than 8 percent. Also included are Alderwood and Tokul soils on till plains, Everett soils on terraces and outwash plains, and Norma soils and Terric Medisaprists in depressional areas and on outwash plains and till plains. Included areas make up about 15 percent of the total acreage.

Permeability of this McKenna soil is slow. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of erosion is slight. A seasonal perched water table is at a depth of 0 to about 6 inches. Ponding occurs from November to April. The effect of the layer of dense glacial till on use and management is similar to that of a hardpan.

This unit is used mainly as woodland and for hay and pasture.

Red alder and western redcedar are the main woodland species on this unit. On the basis of a 50-year site curve, the mean site index is 90 for red alder. The mean annual increment at culmination (CMAI) for red alder at age 40 is 101 cubic feet per acre. Estimates of the site index or yield for western redcedar have not been made. Among the trees of limited extent is western hemlock. Among the common forest understory plants are Oregon-grape, red huckleberry, trailing blackberry, western swordfern, and Oregon oxalis.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced

roads and skid trails are soft when wet, and they are impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling mortality, brush competition, and windthrow hazard are the main limitations in the production of timber. If seed trees are present, natural reforestation of cutover areas by red alder occurs periodically. Western redcedar may be suitable for reforestation. Seasonal wetness and ponding reduce root respiration, which results in high seedling mortality. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings. Because the rooting depth is restricted by the layer of glacial till, trees are commonly subject to windthrow.

This unit is used for hay and pasture. The main limitation is a seasonal perched water table. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Excessive water on the surface can be removed by tile drainage systems if suitable outlets are available. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Fertilizer is needed for optimum growth of grasses and legumes. Legumes benefit from applications of agricultural lime.

The main limitation for building sites is ponding. Drainage is needed if buildings with basements and crawl spaces are constructed.

The main limitations for septic tank absorption fields are depth to the dense glacial till, the seasonal perched water table, ponding, and moderately slow permeability. Conventional septic tank absorption fields often fail or do not function properly. The use of long absorption lines helps to compensate for the moderately slow permeability. Drainage is needed if septic tank absorption fields are installed.

This map unit is in capability subclass IVw.

33-Menzel silt loam, 0 to 3 percent slopes. This very deep, well drained soil is on terraces. It formed in alluvium and volcanic ash. Areas are 20 to 80 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 500 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface is covered with matted roots about 1 inch thick. The surface layer is very dark brown silt loam about 4 inches thick. The subsoil is strong brown and dark yellowish brown silt loam and very fine sandy loam about 12 inches thick. The substratum to a depth of 60 inches or more is light olive brown fine sandy loam. In some areas the substratum is sand and gravelly sand.

Included in this unit are small areas of Puyallup soils on stream terraces, Sultan soils on flood plains, and Nargar soils on high terraces, terrace escarpments, and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Menzel soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. Flooding is rare.

This unit is used mainly for hay and pasture. It is also used as woodland and for homesite development.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 179. On the basis of a 50-year site curve, the mean site index is 180. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is about 190 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Among the common forest understory plants are western swordfern, red huckleberry, vine maple, ladyfern, and deer fern.

The main limitation for the harvesting of timber is seasonal soil wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Brush competition is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

This unit is well suited to hay and pasture. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to maintain uniform growth, discourage selective grazing, and reduce clumpy growth. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. In some years supplemental irrigation is also needed.

The main limitation for homesites and septic tank absorption fields is the hazard of flooding. Flooding can be controlled only by use of major flood control structures.

This map unit is in capability subclass IIc.

34-Mukilteo muck. This very deep, very poorly drained soil is in depressional areas. It formed in organic material derived dominantly from sedges. Areas are irregular in shape and are 20 to 80 acres in size. The native vegetation is mainly sedges and rushes. Elevation is 20 to 1,000 feet. Slope is 0 to 1 percent. The average annual precipitation is about 55 inches, the average annual air temperature is about 50 degrees F, and the
average frost-free season is 150 to 200 days.

Typically, the upper layer is dark reddish brown muck about 4 inches thick. The next layer is dark reddish brown and black organic material about 31 inches thick. The next layer is black organic material about 19 inches

thick. Below this to a depth of 60 inches or more is olive gray fine sandy loam. In some areas a large amount of woody material is in the profile.

Included in this unit are areas of Terric Medisaprists, Orcas peat, and Mukilteo soils that have not been artificially drained. Included areas make up about 10 percent of the total acreage.

Permeability of this Mukilteo soil is moderate. Available water capacity is high. Effective rooting depth is limited by a high water table that is at or near the surface from October to May. Runoff is ponded. In most areas of this unit, the water table is artificially drained to a depth of about 3 or 4 feet during the growing season. Some areas are ponded during the rainy season.

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

This unit, when drained, is well suited to row crops. Tile drainage can be used to lower the water table if a suitable outlet is available. Subsidence is minimized if the water table is maintained immediately below the root zone and is allowed to return to the surface when crops are not being grown.

A suitable cropping system includes 1 or 2 years of oats, 3 or 4 years of blueberries, and 3 to 5 years of grasses and legumes. Continuous cropping with vegetables is suitable if an annual winter cover crop is grown. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit, when drained, is suited to hay and pasture. Grazing when the soil in this unit is wet results in compaction of the surface layer. Excessive water on the surface can be removed by a tile system if a suitable outlet is available. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Fertilizer is needed for optimum growth of grasses and legumes. Legumes also benefit from applications of agricultural lime.

The soil in this unit is not suited to urban development. The main limitations for homesites are ponding and low soil strength. The main limitation for septic tank absorption fields is ponding. Conventional septic tank absorption systems fail or do not function properly on this unit.

This map unit is in capability subclass IIw.

35-Nargar fine sandy loam, 0 to 15 percent slopes. This very deep, well drained soil is on high terraces. It formed in sandy alluvium and volcanic ash. Areas are 20 to 80 acres in size. The native vegetation is mainly conifers. Elevation is 400 to 1,200 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 120 to 180 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and partially decomposed litter about 1 inch thick. The surface layer, where mixed to a depth of about 6 inches, is yellowish red fine sandy loam. The subsoil is yellowish red, brown, and dark yellowish brown fine sandy loam about 20 inches thick. The upper part of the substratum is olive gray, stratified fine sand to coarse sand about 15 inches thick. The lower part of the substratum to a depth of 60 inches or more is light olive brown and olive gray very gravelly loamy coarse sand. In some areas the surface layer is loam or gravelly loam.

Included in this unit are areas of Indianola, Pastik, and Winston soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Nargar soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 185. On the basis of a 50-year site curve, the mean site index is 138. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 195 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Among the common forest understory plants are western swordfern, brackenfern, red huckleberry, ladyfern, vine maple, and salal.

The main limitation for the harvesting of timber is seasonal soil wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and natural regeneration of western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

This unit is suited to use as homesites. The main limitation for septic tank absorption fields is the hazard of seepage. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIIe.

36-Nargar fine sandy loam, 15 to 30 percent slopes. This very deep, well drained soil is on high terraces and terrace escarpments. It formed in sandy alluvium and volcanic ash. Areas are 15 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 400 to 1,200 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 120 to 180 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and partially decomposed litter about 1 inch thick. The surface layer, where mixed to a depth of about 6 inches, is yellowish red fine sandy loam. The subsoil is yellowish red, brown, and dark yellowish brown fine sandy loam about 20 inches thick. The upper part of the substratum is olive gray, stratified fine sand to coarse sand about 15 inches thick. The lower part to a depth of 60 inches or more is light olive brown and olive gray very gravelly loamy sand. In some areas the surface layer is loam or is gravelly fine sandy loam.

Included in this unit are areas of Indianola, Pastik, and Winston soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

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

This unit is used as woodland.

Douglas-fir is the main woodland spec .as on this unit. On the basis of a 100-year site curve, the mean site index is 185. On the basis of a 50-year site curve, the mean site index is 138. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 195 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Among the common forest understory plants are western swordfern, red huckleberry, brackenfern, ladyfern, vine maple, and salal.

The main limitation for the harvesting of timber is seasonal soil wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Brush competition is the main limitation in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and natural regeneration of western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

The main limitation for homesites is steepness of slope. The main limitations for septic tank absorption fields are steepness of slope and seepage. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IVe.

37-Nargar-Lynnwood complex, 30 to 65 percent slopes. This map unit is on terrace escarpments. Areas are irregular in shape and are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 400 to 1,200 feet. The average. annual precipitation is about 55 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 140 to 190 days.

This unit is about 60 percent Nargar fine sandy loam and about 25 percent Lynnwood loamy sand. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Pastik, Skykomish, and Winston soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

The Nargar soil is very deep and well drained. It formed in sandy alluvium and volcanic ash. Typically, the surface is covered with a mat of needles, leaves, and partially decomposed litter about 1 inch thick. The surface layer, where mixed to a depth of about 6 inches, is yellowish red fine sandy loam. The subsoil is yellowish red, brown, and dark yellowish brown fine sandy loam about 20 inches thick. The upper part of the substratum is olive gray, stratified fine sand and coarse sand about 15 inches thick. The lower part to a depth of 60 inches or more is light olive brown and olive gray very gravelly loamy sand.

Permeability of the Nargar soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

The Lynnwood soil is very deep and somewhat excessively drained. It formed in glacial outwash. Typically, the surface is covered with a mat of leaves, needles, and twigs about 3 inches thick. The surface layer is grayish brown loamy sand about 1 inch thick. The upper part of the subsoil is dark brown loamy sand about 14 inches thick. The lower part is dark yellowish brown loamy sand about 14 inches thick. The substratum to a depth of 60 inches or more is grayish brown sand.

Permeability of the Lynnwood soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland.

Douglas-fir is the main woodland species on the Nargar soil. On the basis of a 100-year site curve, the mean site index is 185. On the basis of a 50-year site

curve, the mean site index is 138. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 195 cubic feet per acre.

Douglas-fir is also the main woodland species on the Lynnwood soil. On the basis of a 100-year site curve, the mean site index is 158. On the basis of a 50-year site curve, the mean site index is 121. The mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 168 cubic feet per acre.

Among the trees of limited extent on this unit are western hemlock and western redcedar. Red alder is also of limited extent on the Nargar soil. Among the common forest understory plants are western swordfern, brackenfern, ladyfern, deer fern, red huckleberry, vine maple, and salal.

The main limitation for the harvesting of timber is steepness of slope, which restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and disturb the soil less. Use of wheeled and tracked equipment when the soils in this unit are wet produces ruts, compacts the soils, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment and brush competition are the main limitations for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and natural regeneration of western hemlock occurs periodically on the Nargar soil. The droughtiness of the surface layer of the Lynnwood soil increases seedling mortality, especially on south- and southwest-facing slopes. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings on the Lynnwood soil and prevent establishment on the Nargar soil.

This map unit is in capability subclass VIIe.

38-Nargar Variant sandy loam, 3 to 30 percent slopes. This very deep, well drained soil is on terrace escarpments and mountainsides. It formed in sandy alluvium and volcanic ash. Areas are 10 to 80 acres in size. The native vegetation is mainly conifers. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 45 degrees F, and the average frost-free season is 110 to 140 days.

Typically, the surface is covered with a mat of leaves, twigs, and needles about 2 inches thick. The surface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is reddish brown, dark brown, and dark yellowish brown sandy loam about 27 inches thick. The substratum to a depth of 60 inches or more is yellowish brown and light olive brown loamy coarse sand and very gravelly coarse sandy loam. In some areas the surface layer and subsoil are sandy loam.

Included in this unit are areas of Skykomish soils on terraces and outwash plains and Elwell soils on mountainsides and ridgetops. Included areas make up about 15 percent of the total acreage.

Permeability of this Nargar Variant soil is moderate to the substratum and rapid through it. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 133. On the basis of a 50-year site curve, the mean site index is 92. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 205 cubic feet per acre. Among the trees of limited extent are Douglas-fir and western redcedar. Among the common forest understory plants are vine maple, swordfern, red huckleberry, trillium, and brackenfern.

The main limitation for the harvesting of timber is seasonal soil wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Seedling mortality and brush competition are the main limitations in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs periodically. High soil temperature and low soil moisture content during the growing season cause a high mortality of seedlings, especially on south- and southwest-facing slopes. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation.

The main limitation for homesites is steepness of slope in areas where slopes are more than 15 percent. The main limitations for septic tank absorption fields are steepness of slope and seepage. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IVe.

39-Norma loam. This very deep, poorly drained soil is in depressional areas on outwash plains and till plains. It formed in alluvium. Areas are 10 to 40 acres in size. The native vegetation is mainly hardwood trees. Elevation is 20 to 600 feet. Slope is 0 to 3 percent. The average annual precipitation is about 45 inches, the

average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

Typically, the surface layer is very dark gray loam about 10 inches thick. The subsoil is dark grayish brown sandy loam about 18 inches thick. The substratum to a depth of 60 inches or more is dark gray sandy loam.

Included in this unit are small areas of soils that have a surface layer and subsoil of silt loam and soils that have a gravelly and sandy subsoil. Also included are areas of Bellingham and Custer soils and Terric Medisaprists in depressional areas. Included areas make up about 15 percent of the total acreage.

Permeability of this Norma soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is limited by a seasonal high water table that is at a depth of 0 to about 12 inches. Runoff is very slow, and the hazard of water erosion is slight. Ponding occurs from November to April. In most areas the water table is artificially drained to a depth of about 3 or 4 feet during the growing season, but the soil may be ponded during the rainy season.

This unit is used mainly for hay and pasture and for wildlife habitat. It is also used as woodland and cropland.

This unit, when drained, is well suited to use as cropland. Proper row arrangement, field ditches, and vegetated outlets are needed to remove excess surface water. Tile drainage can be used to lower the water table if a suitable outlet is available.

A suitable cropping system includes 1 or 2 years of sweet corn, 1 to 5 years of raspberries or strawberries, and 3 to 5 years of grasses and legumes. Annual cropping with vegetables and growing a winter cover crop is also suitable. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Returning crop residue to the soil also reduces compaction. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit, when drained, is well suited to hay and pasture. Wetness and submergence limit the choice of plants and the period of cutting or grazing, and they increase the risk of damaging crops. Grazing when the soil in this unit is wet results in compaction of the surface layer. Excessive water on the surface can be removed by tile drains where outlets are suitable.

Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime. In some years supplemental irrigation is needed.

This unit is suited to the production of red alder. On the basis of a 50-year site curve, the mean site index is 106. The mean annual increment at culmination (CMAI) for red alder at age 40 is 128 cubic feet per acre. Among the trees of limited extent are western redcedar, western hemlock, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, trailing blackberry, thimbleberry, and salmonberry.

The main limitation for the harvesting of timber is seasonal soil wetness. A seasonal high water table and ponding limit the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling mortality and brush competition are the main limitations for the production of timber. If seed trees are present, natural reforestation of cutover areas by red alder occurs periodically. The seasonal high water table and ponding reduce root respiration, which results in high mortality of seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation. Because the rooting depth is restricted by the seasonal high water table, trees are subject to windthrow.

This unit is poorly suited to urban development. It is subject to ponding.

This map unit is in capability subclass IIIw.

40-Norma Variant loam. This very deep, poorly drained soil is in depressional areas on outwash plains. It formed in glacial outwash. Areas are 10 to 35 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 400 feet. Slope is 0 to 3 percent. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typically, the surface layer is dark reddish brown loam about 9 inches thick. The subsoil is light olive gray and grayish brown sandy clay loam about 17 inches thick. The substratum to a depth of 60 inches or more is olive gray sandy loam and loamy sand. In some areas the surface layer is silt loam and silty clay loam, and In some areas the soil is somewhat poorly drained.

Included in this unit are areas of Bellingham, Custer, and Norma soils and Terric Medisaprists in depressipnal areas and Ragnar soils on outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Norma Variant soil is moderately slow. Available water capacity is moderate. Effective rooting depth is limited by a seasonal high water table that is at a depth of 0 to about 12 inches. Runoff is very slow, and the hazard of water erosion is slight. Ponding occurs from November to April.

This unit is used mainly for hay and pasture. It also is used as woodland. Where drained, it is used as cropland and for urban development.

This unit, where drained, is suited to use as cropland. Proper row arrangement, field ditches, and vegetated

outlets are needed to remove excess water on the surface. Tile drainage can be used to lower the water table if a suitable outlet is available. In summer irrigation is required for maximum production of most crops.

A suitable cropping system includes 1 or 2 years of corn, 3 to 5 years of raspberries, and 3 to 5 years of grasses and legumes. Growing vegetables and including an annual winter cover crop is also suitable. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Returning crop residue to the soil also reduces compaction. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to hay and pasture. Grazing when the soil in this unit is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Excessive water on the surface can be removed by tile drains if adequate outlets are available. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime. In some years supplemental irrigation is needed.

Red alder is the main woodland species on this unit. On the basis of a 50-year site curve, the estimated mean site index is 60. The mean annual increment at culmination (CMAI) for red alder is 50 cubic feet per acre at age 35. Among the trees of limited extent is western redcedar. Among the common forest understory plants are willow, Oregon ash, sedge, and rose.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling mortality, windthrow hazard, and brush competition are the main limitations for the production of timber. If seed trees are present, natural reforestation of cutover areas by red alder occurs periodically. A seasonal high water table and ponding reduce root respiration, which results in high seedling mortality. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation. Because the rooting depth is restricted by a seasonal high water table, trees are frequently subject to windthrow.

The main limitation for homesites is the seasonal ponding. Drainage is needed if roads and building foundations are constructed. The main limitations for septic tank absorption fields are the seasonal ponding, moderately slow permeability in the subsoil, and seepage in the substratum. Use of long absorption lines helps to compensate for the moderately slow permeability. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIIw.

41-Ogarty-Tokul-Rock outcrop complex, 65 to 90 percent slopes. This map unit is on foothills, mountainsides, and till plains. Areas are 20 to 170 acres in size. The native vegetation is mainly conifers. Elevation is 500 to 1,000 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 180 days.

This unit is about 55 percent Ogarty very gravelly loam, about 20 percent Tokul silt loam, and about 15 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Elwell and Olomount soils on mountainsides and ridgetops. Also included are talus slopes below areas of Rock outcrop. Included areas make up about 10 percent of the total acreage.

The Ogarty soil is moderately deep and moderately well drained. It formed in volcanic ash and glacial till derived dominantly from andesite. Typically, the surface is covered with a mat of litter and decomposed material about 2 inches thick. The surface layer, where mixed to a depth of about 6 inches, is dark brown very gravelly loam. The subsoil is dark brown very gravelly loam and brown extremely gravelly loam about 26 inches thick. The substratum is dark brown and yellowish red extremely gravelly loam about 6 inches thick. Andesite is at a depth of about 38 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Ogarty soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

The Tokul soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of 31 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Tokul soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by

a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is very rapid, and the hazard of water erosion is very high.

Rock outcrop consists of areas where the surface is exposed, unweathered andesite or argillite.

This unit is used mainly as woodland.

Douglas-fir and western hemlock are the main woodland species on the Ogarty soil. On the basis of a 100-year site curve, the mean site index is 150 for Douglas-fir and 169 for western hemlock. On the basis of a 50-year site curve, the mean site index is 117 for Douglas-fir and 115 for western hemlock. The mean annual increment at culmination (CMAI) is 158 cubic feet per acre for Douglas-fir at age 60 and 272 cubic feet per acre for western hemlock at age 50.

Douglas-fir and western hemlock are also the main woodland species on the Tokul soil. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet per acre for Douglas-fir at age 60, and 266 cubic feet per acre for western hemlock at age 50. Rock outcrop reduces yield by about 15 percent.

Among the trees of limited extent on this unit are western redcedar, fir, red alder, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, red huckleberry, salal, and trailing blackberry.

The main limitations for the harvesting of timber are steepness of slope and Rock outcrop. Cable yarding systems generally are used on this unit. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff. Rock outcrop may cause breakage of timber and hinder yarding operations. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit.

Establishing plant cover on steep road cut and fill slopes reduces erosion. Following road construction and clearcutting, road failures and landslides are likely to occur.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and natural regeneration of western hemlock occurs periodically. Rock outcrop limits the even distribution of reforestation. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the hardpan and underlying bedrock, trees are subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This map unit is in capability subclass VIIe.

42-Olomount gravelly loam, 3 to 15 percent slopes. This moderately deep, moderately well drained soil is on mountainsides and ridgetops. It formed in glacial till, volcanic ash, and weathered material derived dominantly from andesite, argillite, and basalt. Areas are 20 to 60 acres in size. The native vegetation is mainly conifers. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface is covered with a mat of leaves, needles, mosses, and partially decomposed litter about 3 inches thick. The surface layer is very dark grayish brown gravelly loam about 2 inches thick. The subsoil is reddish brown and dark brown gravelly loam about 16 inches thick. The substratum is dark brown very gravelly loam and extremely gravelly loam about 14 inches thick. Andesite is at a depth of about 32 inches. Depth to andesite ranges from 20 to 40 inches.

Included in this unit are areas of Elwell soils, Rober soils on terraces and terrace escarpments, and Rock outcrop. Also included are some areas of soils that have andesite at a depth of more than 40 inches. Included areas make up about 15 percent of the total acreage.

Permeability of this Olomount soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A seasonal high water table is at a depth of 18 to 36 inches from November to May.

This unit is used mainly as woodland, watershed, and wildlife habitat.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 152. On the basis of a 50-year site curve, the mean site index is 115. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 241 cubic feet per acre. Among the trees of limited extent are Douglas-fir, western redcedar, Pacific silver fir, red alder, and bigleaf maple. Among the common forest understory plants are brackenfern, vine maple, deer fern, salmonberry, and salal.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Occasional snowpack also hinders harvesting. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit.

Windthrow hazard and brush competition are the main limitations for the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs periodically. Reforestation can be accomplished by planting Douglas-fir seedlings. When

openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation.

Because the rooting depth is restricted by limited depth to bedrock, trees are subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitations for homesites and septic tank absorption fields are depth to rock and the seasonal high water table. Deep cuts can expose bedrock. Drainage is needed if roads and building foundations are constructed. Septic tank absorption lines should be placed on the contour.

This map unit is in capability subclass IVe.

43-Olomount-Elwell-Rock outcrop complex, 65 to 90 percent slopes. This map unit is on mountainsides. The native vegetation is mainly conifers. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 130 to 150 days.

This unit is about 55 percent Olomount gravelly loam, about 25 percent Elwell silt loam, and about 10 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Rober soils on terraces and terrace escarpments, Skykomish soils on terraces and outwash plains, and talus slopes below the Rock outcrop. Included areas make up about 10 percent of the total acreage.

The Olomount soil is moderately deep and moderately well drained. It formed in glacial till, volcanic ash, and material derived dominantly from andesite, argillite, and basalt. Typically, the surface is covered with a mat of leaves, needles, mosses, and partially decomposed litter about 3 inches thick. The surface layer is very dark grayish brown gravelly loam about 2 inches thick. The subsoil is reddish brown and dark brown gravelly loam about 16 inches thick. The substratum is dark brown very gravelly loam and extremely gravelly loam about 14 inches thick. Andesite is at a depth of about 32 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Olomount soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is very rapid, and the hazard of water erosion is very high. A seasonal high water table is at a depth of 18 to 36 inches from November to May.

The Elwell soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface layer is black silt loam about 2 inches thick. The subsoil is strong brown, brown, and yellowish brown silt loam about 21 inches thick. The substratum is pale olive gravelly fine sandy loam about 4 inches thick. An olive, weakly cemented hardpan is at a depth of about 27 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Elwell soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is very rapid, and the hazard of water erosion is very high. A seasonal perched water table is at a depth of 18 to 36 inches from November to June.

Rock outcrop consists of areas where 90 percent of the surface is exposed, unweathered andesite or argillite. It occurs as very steep cliffs.

This unit is used mainly as woodland, watershed, and wildlife habitat.

Western hemlock is the main woodland species on the Olomount soil. On the basis of a 100-year site curve, the mean site index is 152. On the basis of a 50-year site curve, the mean site index is 115. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 241 cubic feet per acre.

Western hemlock is also the main woodland species on the Elwell soil. On the basis of a 100-year site curve, the mean site index is 152. On the basis of a 50-year site curve, the mean site index is 108. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 241 cubic feet per acre. Rock outcrop in this unit reduces yield by about 10 percent.

Among the trees of limited extent are Douglas-fir, western redcedar, Pacific silver fir, red alder, and bigleaf maple. Among the common forest understory plants are western swordfern, red huckleberry, brackenfern, deer fern, salal, vine maple, and salmonberry.

The main limitations for the harvesting of timber is steepness of slope, seasonal soil wetness, and Rock outcrop. Occasional snowpack also hinders harvesting. Cable yarding systems generally are used on this unit. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff. Rock outcrop may cause breakage of timber and hinder yarding operations. Wetness limits the use of equipment to dry periods.

Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion. Following road construction and clearcutting, road failures and landslides are likely to occur. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover.

Windthrow hazard and brush competition are the main limitations for the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs periodically. Reforestation can be accomplished by planting Douglas-fir seedlings. Rock outcrop limits the even distribution of reforestation. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation.

Because the rooting depth is restricted by the hardpan and underlying bedrock, trees are occasionally subject to

windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This map unit is in capability subclass VIIs.

44-Orcas peat. This very deep, very poorly drained soil is in basins on hills. It formed in sphagnum moss. Areas are 10 to 40 acres in size. The native vegetation is mainly sphagnum moss and herbaceous plants. Elevation is 100 to 500 feet. Slope is 0 to 2 percent. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 180 days.

Typically, the upper layer is dark reddish brown organic material about 3 inches thick. Below this to a depth of 60 inches or more is dark brown organic material. In some areas the profile is woody peat.

Included in this unit are areas of Mukilteo soils and Terric Medisaprists in depressional areas. Included areas make up about 10 percent of the total acreage.

Permeability of this Orcas soil is very rapid. Available water capacity is high. Effective rooting depth is limited by a high water table that is at a depth of 0 to 12 inches. Runoff is ponded.

This unit is used for wildlife habitat.
This unit serves as a nesting area for ducks, herons, and other waterfowl. Plantings of smartweed, wild millet, or bulrush encourage added populations. This map unit is in capability subclass Vw.

45-Oso gravelly loam, 3 to 15 percent slopes. This moderately deep, moderately well drained soil is on mountainsides and ridgetops. It formed in glacial till, volcanic ash, and material derived dominantly from andesite. Areas are 20 to 50 acres in size. The native vegetation is mainly conifers. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 90 to 120 days.

Typically, the surface is covered with a mat of leaves, needles, twigs, and mosses about 2 inches thick. The surface layer is black gravelly loam about 3 inches thick. The subsurface layer is light brownish gray gravelly loam about 2 inches thick. The subsoil is dark brown and yellowish brown gravelly loam about 24 inches thick. Andesite is at a depth of about 29 inches. Depth to andesite ranges from 20 to 40 inches.

Included in this unit are small areas of soils that are more than 35 percent coarse fragments and soils that have a cobbly or stony surface layer. Also included are areas of Getchell soils and Rock outcrop. Included areas make up about 10 percent of the total acreage.

Permeability of this Oso soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A seasonal perched water table is at a depth of 18 to 36 inches from November to May.

This unit is used as woodland and watershed and for wildlife habitat.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 129. On the basis of a 50-year site curve, the mean site index is 93. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 198 cubic feet per acre. Among the trees of limited extent are Pacific silver fir and Douglas-fir. Among the common forest understory plants are red huckleberry, trailing blackberry, blue-leaved huckleberry, and bunchberry dogwood.

The main limitation for the harvesting of timber is seasonal soil wetness, which restricts the use of equipment to dry periods. Snowpack also limits the use of equipment and restricts access. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit.

Seedling establishment is the main limitation for the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can delay natural reforestation. Reforestation can be accomplished by planting Douglas-fir seedlings. Because the rooting depth is restricted by underlying bedrock, trees are occasionally subject to windthrow.

The main limitations for homesites and septic tank absorption fields are the depth to rock and the seasonal perched water table. Deep cuts can expose bedrock. Drainage is needed if buildings with basements and crawl spaces are constructed. Septic tank absorption lines should be placed on the contour.

This map unit is in capability subclass VIe.

46-Oso-Getchell-Rock outcrop complex, 65 to 90 percent slopes. This map unit is on mountainsides. Areas are irregular in shape and are 10 to 200 acres in size. The native vegetation is mainly conifers. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 90 to 125 days.

This unit is about 55 percent Oso gravelly loam, about 25 percent Getchell silt loam, and about 10 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Potchub, Elwell, Hartnit, and Olomount soils and Skykomish soils on terraces and outwash plains. Included areas make up about 10 percent of the total acreage.

The Oso soil is moderately deep and moderately well drained. It formed in glacial till, volcanic ash, and

material derived dominantly from andesite. Typically, the surface is covered with a mat of leaves, needles, twigs, and mosses about 2 inches thick. The surface layer is black gravelly loam about 3 inches thick. The subsurface layer is light brownish gray gravelly loam about 24 inches thick. Andesite is at a depth of about 27 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Oso soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is very rapid, and the hazard of water erosion is very high. A seasonal perched water table is at a depth of 18 to 36 inches from November to May.

The Getchell soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of needles, leaves, twigs, and decomposed material about 2 inches thick. The surface layer is black silt loam about 2 inches thick. The subsoil is yellowish red, strong brown, light olive brown, and dark brown silt loam about 34 inches thick. Olive, dense glacial till is at a depth of about 36 inches. Depth to glacial till ranges from 20 to 40 inches.

Permeability of the Getchell soil is moderate to the glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is very rapid, and the hazard of water erosion is very high. A seasonal perched water table is at a depth of 18 to 36 inches from December to May. The effect of the layer of dense glacial till on use and management is similar to that of a hardpan.

Rock outcrop consists of areas where the surface is exposed, unweathered andesite. It occurs as very steep cliffs.

This unit is used mainly as woodland, watershed, and wildlife habitat.

Western hemlock is the main woodland species on the Oso soil. On the basis of a 100-year site curve, the mean site index is 129. On the basis of a 50-year site curve, the mean site index is 93. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 198 cubic feet per acre.

Western hemlock is also the main woodland species on the Getchell soil. On the basis of a 100-year site curve, the mean site index is 130. On the basis of a 50-year site curve, the mean site index is 90. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 200 cubic feet per acre. Rock outcrop in this unit reduces yield by about 10 percent.

Among the trees of limited extent are Pacific silver fir, Douglas-fir, and western redcedar. Among the common forest understory plants are red huckleberry, deer fern, brackenfern, devilsclub, ladyfern, trailing blackberry, blue-leaved huckleberry, and bunchberry dogwood.

The main limitations for the harvesting of timber on this unit are steepness of slope, seasonal soil wetness, and Rock outcrop. Cable yarding systems generally are used on this unit. Harvesting operations that lift logs entirely off the ground reduce the disturbance of the protective layer of duff. A seasonal high water table limits the use of equipment to dry periods. Snowpack also limits the use of equipment and restricts access.

Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Following road construction and clearcutting, road failures and landslides are likely to occur. Establishing plant cover on steep road cut and fill slopes reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless adequate water bars are provided or they are protected by plant cover.

Seedling establishment and windthrow hazard are the main limitations for the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Rock outcrop limits the even distribution of reforestation. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation.

Because the rooting depth is restricted by the underlying bedrock and dense glacial till, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This map unit is in capability subclass VIIs.

47-Pastik silt loam, 0 to 8 percent slopes. This very deep, moderately well drained soil is on terraces. It formed in lake sediment and volcanic ash. Areas are 20 to 100 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface layer is dark brown silt loam about 6 inches thick. The subsoil is dark brown and yellowish brown silt loam about 23 inches thick. The substratum to a depth of 60 inches or more is light olive gray silt loam. In some areas the surface layer and subsoil are fine sandy loam and loamy fine sand.

Included in this unit are areas of Bellingham soils in depressional areas, Nargar soils on high terraces, Ragnar soils on outwash plains, and Tokul soils on till plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Pastik soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 30 inches from December to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used for hay and pasture and for urban development.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 180. On the basis of a 50-year site curve, the

mean site index is 135. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 191 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, ladyfern, red huckleberry, and deer fern.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow.

This unit is suited to hay and pasture. The main limitations are slope and the seasonal high water table. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Excessive water on the surface can be removed by tile drains if adequate outlets are available. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

Periodic mowing and clipping help to maintain uniform growth, discourage selective grazing, and reduce clumpy growth. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime.

The main limitation for homesites is the seasonal high water table. Wetness can be reduced by installing drain tile around footings. The main limitations for septic tank absorption fields are the seasonal high water table and slow permeability. Use of long absorption lines helps to compensate for the slow permeability. Disturbed areas need to be seeded to grass. Temporary sediment basins are needed where construction leaves soil areas bare of cover.

This map unit is in capability subclass IIe.

48-Pastik silt loam, 8 to 25 percent slopes. This very deep, moderately well drained soil is on terraces. It formed in lake sediment and volcanic ash. Areas are 10 to 50 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface layer is dark brown silt loam about 6 inches thick. The subsoil is dark brown and yellowish brown silt loam about 23 inches thick. The substratum to a depth of 60 inches or more is light olive gray silt loam. In some areas the surface layer and subsoil are fine sandy loam and loamy fine sand.

Included in this unit are areas of Nargar soils on high terraces, Ragnar soils on outwash plains, and Tokul soils on till plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Pastik soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 30 inches from December to May. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It is also used for hay and pasture and urban development.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 180. On the basis of a 50-year site curve, the mean site index is 135. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 191 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, ladyfern, red huckleberry, and deer fern.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation. Because the rooting depth is restricted by the high water table, trees are occasionally subject to windthrow.

This unit is suited to hay and pasture. The main limitations are the seasonal high water table and slope. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Excessive water on the surface can be removed by tile drains if adequate outlets are available.

Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion. Periodic mowing, spreading of droppings, and clipping help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime.

The main limitations for homesites are the seasonal high water table and steepness of slope in areas where slopes are more than 15 percent. Wetness can be reduced by installing drain tile around footings. The hazard of erosion is increased if the soil in this unit is left exposed during site development. Areas where the soil is bare need to be seeded to grass. Temporary sediment basins are needed where construction leaves soil areas bare of cover. Topsoil should be stockpiled and used to reclaim areas disturbed by cutting and filling. Access roads must be designed to control surface runoff and to help stabilize cut slopes.

The main limitations for septic tank absorption fields are the seasonal high water table, slow permeability, and steepness of slope in areas where slopes are more than 15 percent. Use of long absorption lines helps to compensate for the slow permeability. Septic tank absorption lines should be on the contour.

This map unit is in capability subclass IIIe.

49-Pastik silt loam, 25 to 50 percent slopes. This very deep, moderately well drained soil is on terraces. It formed in lake sediment and volcanic ash. Areas are 10 to 70 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface layer is dark brown silt loam about 6 inches thick. The subsoil is dark brown and yellowish brown silt loam about 23 inches thick. The substratum to a depth of 60 inches or more is light olive gray silt loam. In some areas the surface layer and subsoil are fine sandy loam and loamy fine sand.

Included in this unit are areas of Nargar soils on high terraces, Ragnar soils on outwash plains, and Tokul soils on till plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Pastik soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 30 inches from December to May. Runoff is rapid and the hazard of water erosion is high.

This unit is used mainly as woodland.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 180. On the basis of a 50-year site curve, the mean site index is 135. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 191 cubic feet per acre. Among the trees of limited extent are western hemlock, western redcedar, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, red huckleberry, and deer fern.

The main limitations for the harvesting of timber are steepness of slope and seasonal soil wetness. Steepness of slope restricts the use of wheeled and tracked equipment in skidding operations; cable yarding systems generally are safer and disturb the soil less.

The seasonal high water table limits the use of equipment to dry periods. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation. Because the rooting depth is restricted by the high water table, trees are occasionally subject to windthrow.

The main limitations for homesites are steepness of slope and the seasonal high water table. Wetness can be reduced by installing drain tile around footings. The main limitations for septic tank absorption fields are the seasonal high water table, slow permeability, and steepness of slope. The hazard of erosion is increased if the soil in this unit is left exposed during site development. Access roads must be designed to control surface runoff and to help stabilize cut slopes. Topsoil should be stockpiled and used to reclaim areas disturbed by cutting and filling.

This map unit is in capability subclass VIe.

50-Pilchuck loamy sand. This very deep, somewhat excessively drained soil is on flood plains. It formed in alluvium. Areas are long and narrow and are 10 to 50 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 20 to 800 feet. Slope is 0 to 3 percent. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface layer, where mixed to a depth of about 4 inches, is dark grayish brown loamy sand. The upper part of the underlying material is black loamy sand about 27 inches thick. The next part is light gray fine sand about 19 inches thick. The lower part to a depth of 60 inches or more is light gray gravelly sand.

Included in this unit are small areas of soils that have a surface layer of loam, gravelly loam, or cobbly loam and are gravelly or cobbly in the upper part of the substratum. Also included are areas of Sultan soils, Puget soils in depressional areas, and Puyallup soils on stream terraces. Included areas make up about 15 percent of the total acreage.

Permeability of this Pilchuck soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow. A seasonal high water table is at a depth of 24 to 48 inches from

November to April. Flooding is frequent from November to April.

This unit is used mainly as woodland. It is also used for pasture.

Douglas-fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 152. On the basis of a 50-year site curve, the mean site index is 115. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 161 cubic feet per acre. Among the trees of limited extent are black cottonwood, red alder, and bigleaf maple. Among the common forest understory plants are vine maple, western swordfern, salmonberry, common snowberry, and false-Solomons-seal.

The main limitation for harvesting of timber is soil wetness. Frequent seasonal flooding limits the use of equipment to dry periods in summer. Logging roads require suitable surfacing for year-round use. Damage to roads from flooding is likely. Rock for road construction is not readily available on this unit.

Seedling mortality and brush competition are the main limitations for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation. Wetness reduces root respiration, which results in high seedling mortality.

If this unit is used for pasture, the main limitations are the low available water capacity, low soil fertility, and the hazard of flooding. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. In some years supplemental irrigation is needed.

The main limitations for homesites are seasonal flooding and wetness. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings. The main limitations for septic tank absorption fields are the hazard of flooding, wetness, and seepage. The soil material in this unit is a poor filter for effluent from conventional septic tank absorption fields.

This map unit is in capability subclass IVw.

51-Pits. This map unit consists of gravel pits, sand pits, and rock quarries. Areas average 5 to 15 acres in size and are irregular in shape. Elevation is 100 to 2,000 feet. About 50 percent of the pits mapped were in active use, and about 50 percent were abandoned.

With proper reclamation, these areas can be revegetated and improved for use as wildlife habitat.

This map unit is in capability subclass VIIIs.

52-Potchub silt loam, 3 to 30 percent slopes. This moderately deep, moderately well drained soil is on mountainsides and ridgetops. It formed in glacial till and volcanic ash. Areas are irregular in shape and are 100 to 300 acres in size. The native vegetation is mainly conifers. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free season is 90 to 100 days.

Typically, the surface is covered with a mat of leaves, needles, twigs, and decomposed organic litter about 9 inches thick. The surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is pinkish gray silt loam about 3 inches thick. The subsoil is dark reddish brown, strong brown, and dark brown silt loam about 24 inches thick. Olive, dense glacial till is at a depth of about 34 inches. Depth to glacial till ranges from 20 to 40 inches.

Included in this unit are areas of Getchell, Hartnit, and Verlot soils and Cryohemists in depressional areas. Also included are some areas of soils in which depth to glacial till is more than 40 inches. Included areas make up about 15 percent of the total acreage.

Permeability of this Potchub soil is moderate to the glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A seasonal perched water table is at a depth of 18 to 36 inches from November to May. The effect of the layer of dense glacial till on use and management is similar to that of a hardpan.

This unit is used as woodland and watershed.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 68. On the basis of a 50-year site curve, the mean site index is 56. The mean annual increment at culmination (CMAI) for western hemlock at age 60 is 70 cubic feet per acre. Among the trees of limited extent are Pacific silver fir and Douglas-fir. Among the common forest understory plants are red huckleberry, trailing blackberry, blue-leaved huckleberry, bunchberry dogwood, and deer fern.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Snowpack also limits the use of equipment and restricts access. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Establishing plant cover on steep road cut and fill slopes reduces erosion. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern for the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation.

Because the rooting depth is restricted by the seasonal perched water table and the glacial till, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This map unit is in capability subclass VIIe.

53-Potchub-Hartnit complex, 15 to 30 percent slopes. This map unit is on mountainsides and ridgetops. Areas are 30 to 120 acres in size. The native vegetation is mainly conifers. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free season is 90 to 100 days.

This unit is about 60 percent Potchub silt loam and about 25 percent Hartnit gravelly silt loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Getchell, Oso, and Verlot soils and Cryohemists, nearly level, in depressional areas. Included areas make up about 15 percent of the total acreage.

The Potchub soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of leaves, needles, twigs, and decomposed organic litter about 9 inches thick. The surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is pinkish gray silt loam about 3 inches thick. The subsoil is dark reddish brown, strong brown, and dark brown silt loam about 24 inches thick. Olive, dense glacial till is at a depth of about 34 inches. Depth to glacial till ranges from 20 to 40 inches.

Permeability of the Potchub soil is moderate to the glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion ismoderate. A seasonal perched water table is at a depth of 18 to 36 inches from November to May. The effect of the layer of dense glacial till on use and management is similar to that of a hardpan.

The Hartnit soil is moderately deep and moderately well drained. It formed in glacial till, volcanic ash, and material derived dominantly from andesite, argillite, and basalt. Typically, the surface is covered with a mat of leaves, needles, twigs, and decomposed material about7 inches thick.. The surface layer is black gravelly silt loam about 4 inches thick. The subsurface layer is gray gravelly silt loam about 3 inches thick. The subsoil is dark reddish brown, strong brown, and dark brown gravelly silt loam about 20 inches thick. Andesite is at a depth of about 27 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Hartnit soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A seasonal high water table is at a depth of 18 to 40 inches from November to May.

This unit is used mainly as woodland and watershed.

Western hemlock is the main woodland species on the Potchub soil. On the basis of a 100-year site curve, the mean site index is 68. On the basis of a 50-year site curve, the mean site index is 56. The mean annual increment at culmination (CMAI) for western hemlock at age 60 is 70 cubic feet per acre.

Western hemlock is also the main woodland species on the Hartnit soil. On the basis of a 100-year site curve, the estimated mean site index is 60. On the basis of a 50-year site curve, the estimated mean site index is 45. The estimated mean annual increment at culmination (CMAI) for western hemlock at age 70 is 57 cubic feet per acre.

Among the trees of limited extent on this unit are Pacific silver fir and Douglas-fir. Among the common forest understory plants are red huckleberry, trailing blackberry, blue-leaved huckleberry, bunchberry dogwood, and deer fern.

The main limitation for the harvesting of timber on this unit is seasonal soil wetness, which limits the use of equipment to dry periods. Snowpack also limits the use of equipment and restricts access. Use of wheeled and tracked equipment when the soils in this unit are wet produces ruts, compacts the soils, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit.

Establishing plant cover on steep road cut and fill slopes reduces erosion. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Seedling establishment is the main concern for the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation.

Because the rooting depth is restricted by the high water table and limited depth to bedrock, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This map unit is in capability subclass VIIe.

54-Potchub-Hartnit-Rock outcrop complex, 30 to 65 percent slopes. This map unit is on mountainsides. Areas are 20 to 200 acres in size. The native vegetation is mainly conifers. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free season is 90 to 100 days.

This unit is about 50 percent Potchub silt loam, about 25 percent Hartnit gravelly silt loam, and about 10

percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Getchell, Oso, and Verlot soils on ridgetops and mountainsides. Included areas make up about 15 percent of the total acreage.

The Potchub soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of leaves, needles, twigs, and decomposed organic litter about 9 inches thick. The surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is pinkish gray silt loam about 3 inches thick. The subsoil is dark reddish brown, strong brown, and dark brown silt loam about 24 inches thick. Olive, dense glacial till is at a depth of about 34 inches. Depth to glacial till ranges from 20 to 40 inches.

Permeability of the Potchub soil is moderate to the glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A seasonal high water table is at a depth of 18 to 36 inches from November to May. The effect of the layer of dense glacial till on use and management is similar to that of a hardpan.

The Hartnit soil is moderately deep and moderately well drained. It formed in glacial till, volcanic ash, and material derived dominantly from andesite, argillite, and basalt. Typically, the surface is covered with a mat of leaves, needles, twigs, and decomposed material about 7 inches thick. The surface layer is black gravelly silt loam about 4 inches thick. The subsurface layer is gray gravelly silt loam about 3 inches thick. The subsoil is dark reddish brown, strong brown, and dark brown gravelly silt loam about 20 inches thick. Andesite is at a depth of about 27 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Hartnit soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A seasonal high water table is at a depth of 18 to 40 inches from November to May.

Rock outcrop consists of areas where the surface is exposed, very hard andesite or argillite. It occurs as very steep cliffs.

This unit is used mainly as woodland and watershed.

Western hemlock is the main woodland species on the Potchub soil. On the basis of a 100-year site curve, the mean site index is 68. On the basis of a 50-year site curve, the mean site index is 56. The mean annual increment at culmination (CMAI) for western hemlock at age 60 is 70 cubic feet per acre.

Western hemlock is also the main woodland species on the Hartnit soil. On the basis of a 100-year site curve, the estimated mean site index is 60. On the basis of a 50-year site curve, the estimated mean site index is 45. The estimated mean annual increment at culmination (CMAI) for western hemlock is 57 cubic feet per acre at age 70.

Rock outcrop in this unit reduces yield by about 10 percent. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of the unit.

Among the trees of limited extent on this unit are Pacific silver fir and Douglas-fir. Among the common forest understory plants are red huckleberry, trailing blackberry, blue-leaved huckleberry, bunchberry dogwood, and deer fern.

The main limitations for the harvesting of timber on this unit are steepness of slope, seasonal soil wetness, and Rock outcrop. Steepness of slope restricts the use of wheeled and tracked equipment in skidding operations; cable yarding systems generally are safer and disturb the soils less. The seasonal high water table limits the use of equipment to dry periods. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit.

Rock outcrop may hinder yarding operations. Snowpack limits the use of equipment and restricts access. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Seedling establishment is the main limitation for the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Rock outcrop limits the even distribution of reforestation. When openings are made in the canopy, invading brushy plants, if not controlled, can delay reforestation.

Because the rooting depth is restricted by the high water table and limited depth to bedrock, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This map unit is in capability subclass VIIe.

55-Puget silty clay loam. This very deep soil is in depressional areas on flood plains. It has been artificially drained. The soil formed in alluvium. Areas are 40 to 200 acres in size. The native vegetation is mainly hardwoods. Elevation is near sea level to 650 feet. Slope is 0 to 2 percent. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typically, the surface layer is dark grayish brown silty clay loam about 9 inches thick. The underlying material to a depth of 60 inches or more is olive gray and gray silty clay loam. In some areas the soil is not drained and is not protected from flooding.

Included in this unit are areas of Snohomish, Sumas, Sultan, and Pilchuck soils on flood plains and Puyallup soils on stream terraces. Included areas make up about 15 percent of the total acreage.

Permeability of this Puget soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. A seasonal high water table is at a depth of 24 to 48 inches from November to April. This soil is partially protected from flooding; however, rare periods of flooding occur from December to March.

This unit is used mainly as cropland and for homesite development. A few areas are used for woodland.

Where this unit is drained and protected from flooding, it is suited to use as cropland. It is limited mainly by the seasonal high water table. Proper row arrangement, field ditches, and vegetated outlets are needed to remove excess surface water. Tile drainage can be used to lower the water table if a suitable outlet is available. Flooding can be controlled by the use of levees and dikes. In summer, irrigation is required for maximum production of most crops.

A suitable cropping system is one that includes 1 to 3 years of peas, cauliflower, cabbage, corn, or strawberries and 3 or 4 years of hay and pasture (fig. 3). Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Compaction can also be reduced by returning crop residue to the soil. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to use as woodland. On the basis of a 50-year site curve, the estimated mean site index for red alder is 95. The estimated mean annual increment at culmination (CMAI) for red alder at 40 years of age is

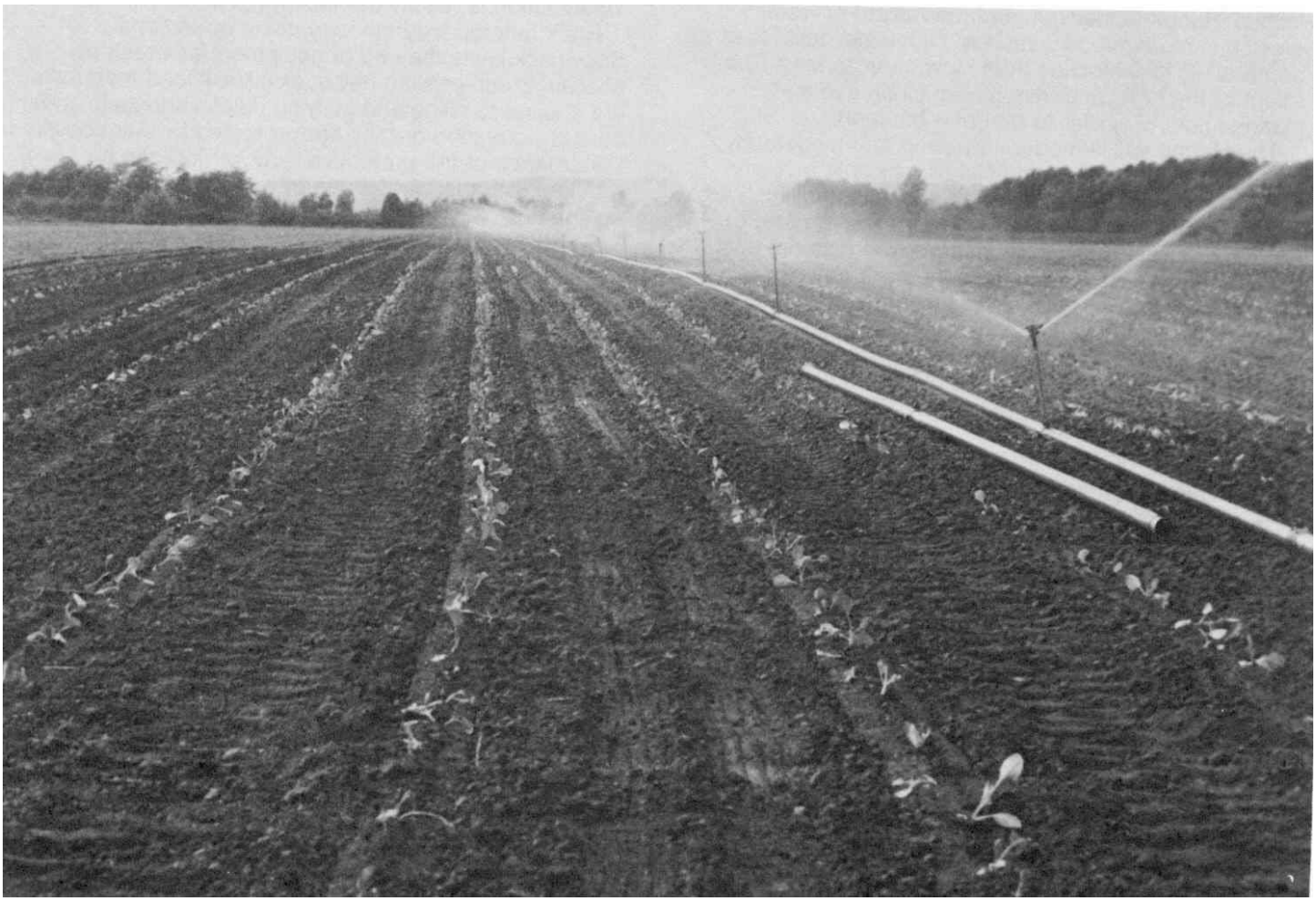

Figure 3.-Irrigated cabbage for seed on Puget silty clay loam.

109 cubic feet per acre. Other suitable trees include black cottonwood, Sitka spruce, western redcedar, and Douglas-fir.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are sticky, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow.

The main limitations for homesites are the hazard of flooding and seasonal soil wetness. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Wetness can be reduced by installing drain tile around footings.

The main limitations for septic tank absorption fields are wetness and slow permeability. Use of long absorption lines helps to compensate for the slow permeability.

This map unit is in capability subclass IIw.

56-Puyallup fine sandy loam. This very deep, well drained soil is on stream terraces. It formed in alluvium of mixed origin. Areas are 10 to 40 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 20 to 500 feet. Slope is 0 to 3 percent. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

Typically, the surface layer is very dark grayish brown fine sandy loam about 10 inches thick. The upper part of the underlying material is dark grayish brown and olive brown fine sandy loam about 20 inches thick. The lower part to a depth of 60 inches or more is dark grayish brown sand. In some areas the surface layer is loam and sandy loam.

Included in this unit are areas of Puget soils in depressional areas on flood plains and Pilchuck, Sultan, Sultan Variant, and Sumas soils on flood plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Puyallup soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. Rare periods of flooding occurs from November to April.

This unit is used mainly as cropland and for hay and pasture and homesite development. A few areas are used as woodland.

This unit is well suited to use as cropland. The main limitation is the moderate available water capacity. In summer supplemental irrigation is required for maximum production of most crops. A suitable cropping system is one that includes 3 or 4 years of strawberries, sweet corn, snap beans, or green peas and 2 to 4 years of hay and pasture. Annual cropping with vegetables and growing a winter cover crop to be used as green manure is also a suitable cropping system.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to hay and pasture. The main limitation is the moderate available water capacity. In some years supplemental irrigation is needed. The use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Fertilizer is needed for optimum growth of grasses and legumes. Legumes also benefit from applications of agricultural lime.

This unit is suited to use as woodland. On the basis of a 100-year site curve, the estimated mean site index for Douglas-fir is 170. On the basis of a 50-year site curve, the estimated mean site index for Douglas-fir is about 115. On the basis of a 50-year site curve, the estimated mean site index for red alder is about 85. The estimated mean annual increment at culmination (CMAI) is about 159 cubic feet per acre for Douglas-fir at about 60 years of age and about 92 cubic feet per acre for red alder at about 40 years of age.

The main limitation for the harvesting of timber is the hazard of flooding. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Brush competition is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily.

The main limitation for homesites is the hazard of flooding. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings. Cutbanks are not stable and are subject to caving in. The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIs.

57-Ragnar fine sandy loam, 0 to 8 percent slopes. This very deep, well drained soil is on outwash plains. It formed in glacial outwash. Areas are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 300 to 1,000 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typically, the surface is covered with a mat of partially decomposed leaves, needles, and twigs about 2 inches thick. The surface layer is dark brown fine sandy loam about 2 inches thick. The subsoil is dark brown and brown sandy loam about 22 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown and dark gray loamy sand and sand. In some areas the surface layer is loamy, the subsoil is gravelly, and the substratum is very gravelly.

Included in this unit are areas of Everett, Indianola, Pastik, and Winston soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Ragnar soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for homesite development. It is also used as cropland, hay and pasture, and woodland.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100year site curve, the mean site index is 165 for Douglas-fir and 159 for western hemlock. On the basis of a 50-year site curve, the mean site index is 125 for Douglas-fir and 112 for western hemlock. The mean annual increment at culmination (CMAI) is 176 cubic feet per acre for Douglas-fir at age 60 and 252 cubic feet per acre for western hemlock at age 50. Among the trees of limited extent are red alder and western redcedar. Among the common forest understory plants are western swordfern, brackenfern, Oregon-grape, salal, and huckleberry.

This unit is well suited to year-round logging; however, logging roads require suitable surfacing for year-round use.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by Douglas fir and red alder occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings. The droughtiness of the surface layer reduces the survival of seedlings.

This unit is suited to hay and pasture. The main limitation is moderate available water capacity. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. In some years supplemental irrigation is needed. Legumes benefit from applications of agricultural lime.

This unit is suited to use as cropland. A suitable cropping system is strawberries, sweet corn, or peas for 3 or 4 years and grasses and legumes for 3 to 5 years. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorous, boron, sulfur and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. Fall tillage or seeding should be across the slope or on the contour.

This unit has few limitations for homesites. The main limitation for septic tank absorption fields is seepage in the substratum. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIIe.

58-Ragnar fine sandy loam, 8 to 15 percent slopes. This very deep, well drained soil is on outwash plains. It formed in glacial outwash. Areas are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 300 to 1,000 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and-the average frost-free season is 180 to 200 days.

Typically, the surface is covered with a mat of partially decomposed leaves, needles, and twigs about 2 inches thick. The surface layer is dark brown fine sandy loam about 2 inches thick. The subsoil is dark brown and brown sandy loam about 22 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown and dark gray loamy sand and sand.

Included in this unit are small areas of soils that have a loamy sand surface layer, a gravelly subsoil, and a very gravelly substratum. Also included are areas of Everett, Indianola, Pastik, and Winston soils on terraces. Included areas make up about 15 percent of the total acreage.

Permeability of this Ragnar soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It is also used for hay and pasture and for homesite development.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 165 for Douglas-fir and 159 for western hemlock. On the basis of a 50-year

site curve, the mean site index is 125 for Douglas-fir and 112 for western hemlock. The mean annual increment at culmination (CMAI) is 176 cubic feet per acre for Douglas-fir at age 60 and 252 cubic feet per acre for western hemlock at age 50. Among the trees of limited extent are red alder and western redcedar. Among the common forest understory plants are western swordfern, brackenfern, Oregon-grape, salal, and huckleberry.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by Douglas-fir and red alder occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings. The droughtiness of the surface layer reduces the survival of seedlings, especially on south- and southwest-facing slopes.

This unit is suited to hay and pasture. The main limitation is the moderate available water capacity. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion. Periodic mowing and spreading of manure help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. In some years supplemental irrigation is needed. Legumes benefit from applications of agricultural lime.

The main limitation for homesites is steepness of slope, and the main limitation for septic tank absorption fields is seepage in the substratum. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIIe.

59-Riverwash. This map unit is on flood plains along streams. It formed in recent alluvium consisting of sand, gravel, cobbles, and stones. It is very deep and somewhat excessively drained. Areas are long and narrow and are 5 to 20 acres in size. This unit supports little if any vegetation. Elevation is 30 to 1,000 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 130 to 180 days.

Texture of the soil material and the content of gravel, cobbles, and stones vary widely within short distances.

Included in this unit are small areas of sand bars. Also included are areas of Pilchuck soils. Included areas make up about 30 percent of the total acreage.

Riverwash is subject to frequent flooding. Overflow and alteration by severe erosion and deposition are frequent.

Some areas of this unit are suitable as a source of sand and gravel.

This map unit is in capability subclass VIIIw.

60-Rober silt loam, 0 to 15 percent slopes. This very deep, moderately well drained soil is on terraces and terrace escarpments. It formed in lacustrine sediment. Areas are 25 to 75 acres in size. The native vegetation is mainly conifers. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface is covered with a mat of leaves, needles, mosses, and partially decomposed litter about 4 inches thick. The surface layer is very dark brown silt loam about 3 inches thick. The subsoil is dark reddish brown, reddish brown, and yellowish brown silt loam about 19 inches thick. The substratum to a depth of 60 inches or more is grayish brown, stratified silt loam and silty clay loam. In some areas the surface layer is stony.

Included in this unit are small areas of granite Rock outcrop. Also included are small areas of Bellingham Variant soils in drainageways, Elwell soils on mountainsides and ridgetops, and Skykomish soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Rober soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 24 to 40 inches from December to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used for homesite development.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 156. On the basis of a 50-year site curve, the mean site index is 111. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 248 cubic feet per acre.

Among the trees of limited extent are Douglas-fir and western redcedar. Among the common forest understory plants are western swordfern, brackenfern, ladyfern, red huckleberry, and Oregon-grape.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are

present, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the seasonal perched water table, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitation for homesites is the seasonal high water table. Wetness can be reduced by installing drain tile around footings. The main limitations for septic tank absorption fields are the seasonal high water table and slow permeability. Septic tank absorption fields do not function properly during rainy periods because of wetness. Use of long absorption lines helps to compensate for the slow permeability.

This map unit is in capability subclass IVe.

61-Rober silt loam, 15 to 30 percent slopes. This very deep, moderately well drained soil is on terraces and terrace escarpments. It formed in lacustrine sediment. Areas are 10 to 50 acres in size. The native vegetation is mainly conifers. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and average frost-free season is 130 to 150 days.

Typically, the surface is covered with a mat of leaves, needles, mosses, and partially decomposed litter about 4 inches thick. The surface layer is very dark brown silt loam about 3 inches thick. The subsoil is dark reddish brown, reddish brown, and yellowish brown silt loam about 19 inches thick. The substratum to a depth of 60 inches or more is grayish brown, stratified silt loam and silty clay loam. In some areas the surface layer is stony.

Included in this unit are small areas of granite Rock outcrop. Also included are areas of Elwell soils on mountainsides and plateaus and Skykomish soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Rober soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 24 to 40 inches from December through May. Runoff is medium, and the hazard of water erosion is moderate. This soil is subject to hillside slippage.

This unit is used mainly as woodland. It is also used for homesite development.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 156. On the basis of a 50-year site curve, the mean site index is 111. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 248 cubic feet per acre. Among the trees of limited extent are Douglas-fir and western redeedar. Among the common forest understory plants are western swordfern, brackenfern, ladyfern, red huckleberry, and Oregon-grape.

The main limitation for the harvesting of timber is seasonal soil wetness, which restricts the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Establishing plant cover on steep road cut and fill slopes reduces erosion. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Plant competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the perched water table, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitations for homesites are steepness of slope, hillside slippage, and wetness. Wetness can be reduced by installing drain tile around footings. The main limitations for septic tank absorption fields are the seasonal high water table, slow permeability, and steepness of slope. Septic tank absorption fields do not function properly during rainy periods because of wetness. Use of long absorption lines helps to compensate for the slow permeability. Disturbed areas need to be seeded to grass to control erosion.

This map unit is in capability subclass IVe.

62-Rober silt loam, 30 to 65 percent slopes. This very deep, moderately well drained soil is on terrace escarpments. It formed in lacustrine sediment. Areas are 20 to 150 acres in size. The native vegetation is mainly conifers. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 130 to 150 days.

Typically, the surface is covered with a mat of leaves, needles, mosses, and partially decomposed litter about 4 inches thick. The surface layer is very dark brown silt loam about 3 inches thick. The subsoil is dark reddish brown, reddish brown, and yellowish brown silt loam about 19 inches thick. The substratum to a depth of 60 inches or more is grayish brown, stratified silt loam and silty clay loam. In some areas the surface layer is stony.

Included in this unit are small areas of granite Rock outcrop. Also included are areas of Elwell soils on mountainsides and ridgetops and Skykomish soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Rober soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 24 to 40 inches from December to May. Runoff is rapid, and the hazard of water erosion is high. This soil is subject to hillside slippage.

This unit is used mainly as woodland.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 156. On the basis of a 50-year site curve, the mean site index is 111. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 248 cubic feet per acre.

Among the trees of limited extent are Douglas-fir and western redcedar. Among the common forest understory plants are western swordfern, brackenfern, ladyfern, red huckleberry, and Oregon-grape.

The main limitations for the harvesting of timber are steepness of slope and seasonal soil wetness, which restricts the use of equipment to dry periods. When harvesting timber, steepness of slope restricts the use of wheeled and tracked equipment in skidding operations; cable yarding systems generally are safer and disturb the soil less.

Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Plant competition is the main limitation in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the perched water table, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This map unit is in capability subclass VIIe.

63-Skykomish gravelly loam, 0 to 30 percent slopes. This very deep, somewhat excessively drained soil is on terraces, terrace escarpments, and outwash plains. It formed in glacial outwash and volcanic ash. Areas are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 400 to 1,600 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 47 degrees F, and the average frost-free season is 85 to 125 days.

Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 4 inches thick. The surface layer is dark reddish brown and yellowish red gravelly loam about 12 inches thick. The subsoil is yellowish red very gravelly fine sandy loam about 7 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown and very dark grayish brown extremely gravelly loamy coarse sand and extremely gravelly coarse sand. In some areas the surface layer is gravelly sandy loam.

Included in this unit are areas of Elwell and Olomount soils on mountainsides and ridgetops and Rober soils on terraces and terrace escarpments. Also included are areas of soils, on terrace escarpments, that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability of this Skykomish soil is moderately rapid to the substratum and very rapid through it. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland, watershed, and wildlife habitat. It is also used for homesite development.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 152. On the basis of a 50-year site curve, the mean site index is 106. The mean annual increment at culmination (CMAI) for western hemlock at age 50 is 241 cubic feet per acre.

Among the trees of limited extent are Douglas-fir, western redcedar, and red alder. Among the common forest understory plants are red huckleberry, western swordfern, brackenfern, salmonberry, and deer fern.

The main limitation for the harvesting of timber is seasonal soil wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Occasional snowpack hinders the use of equipment. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Seedling mortality and brush competition are the main limitations for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs periodically. The droughtiness of the surface layer reduces the survival of seedlings, especially on south- and southwest-facing slopes. If openings are made in the canopy, invading brushy plants can delay reforestation.

The main limitation for homesites is steepness of slope, and the main limitations for septic tank absorption fields are steepness of slope and seepage. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage from onsite

sewage disposal systems. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IVe.

64-Snohomish silt loam. This very deep soil is on flood plains. The soil has been artificially drained. It formed in alluvium underlain by peat and muck. Areas .are 10 to 40 acres in size. The native vegetation is mainly hardwoods. Elevation is 50 to 150 feet. Slope is 0 to 2 percent. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typically, the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsoil is gray and very dark grayish brown silty clay loam about 23 inches thick. Below this to a depth of 60 inches or more is dark reddish brown, very dark grayish brown, and very dark gray organic material. Depth to organic material ranges from 17 to 32 inches. In some areas the surface layer is silty clay loam or the soil is not artificially drained.

Included in this unit are areas of Sumas soils, Mukilteo soils in depressional areas, and Puget soils in depressional areas on flood plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Snohomish soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 48 inches from November to May. Runoff is very slow, and the hazard of water erosion is slight. This soil is partially protected from flooding; however, rare periods of flooding occur from November to April.

This unit is used mainly as cropland and for homesite development. A few areas are used as woodland.

This unit, where drained and protected from flooding, is suited to use as cropland. It is limited mainly by the seasonal high water table. Proper row arrangement, field ditches, and vegetated outlets are needed to remove excess surface water. The seasonal high water table generally limits the suitability of the unit for deep-rooted crops. Tile drainage can be used to lower the water table if a suitable outlet is available.

In summer supplemental irrigation is required for maximum production of most crops. Because of the slow permeability of the soil, the length of runs should be adjusted to permit adequate infiltration of water.

A suitable cropping system is one that includes 2 or 3 years of peas or sweet corn and 2 to 4 years of forage crops used as green chop. An annual crop of vegetables and a winter cover crop to be used as green manure is also suitable. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth.

Crop residue left on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Returning crop residue to the soil and using minimum tillage help to reduce compaction. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to use as woodland. On the basis of a 50-year site curve, the estimated mean site index for red alder is 80. The estimated mean annual increment at culmination (CMAI) for red alder at 40 years of age is about 84 cubic feet per acre.

The main limitation for the harvesting of timber is wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they are impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment is the main concern for the production of timber. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay establishment of seedlings.

The main limitation for homesites are the hazard of flooding, wetness, and low soil strength. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings from flooding. Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load. Tile drains can be used to lower the water table around footings.

The main limitations for septic tank absorption fields are the seasonal high water table and slow permeability. Use of long absorption lines helps to compensate for the slow permeability.

This map unit is in capability subclass IIw.

65-Sulsavar gravelly loam, 0 to 8 percent slopes. This very deep, well drained soil is on terraces and alluvial fans. It formed in volcanic ash and alluvium. Areas are 10 to 55 acres in size. The native vegetation is mainly conifers. Elevation is 400 to 1,200 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 120 to 180 days.

Typically, the surface is covered with a mat of leaves, needles, twigs, and mosses about 1 inch thick. The surface layer is dark brown gravelly loam about 3 inches thick. The subsoil is stratified dark brown and yellowish brown gravelly sandy loam, silt loam, and gravelly loam about 30 inches thick. The substratum to a depth of 60 inches or more is stratified, dark brown and brown sandy loam, very gravelly loamy sand, and gravelly sandy loam. In some areas the surface layer is very gravelly, and in some areas a water table is at a depth of 25 to 40 inches.

Included in this unit are areas of soils that have slopes of more than 8 percent; Menzel, Pastik, Skykomish, and Winston soils on terraces and outwash plains; Elwell

soils on mountainsides and ridgetops; Puyallup soils on stream terraces; Sultan soils on flood plains; and Tokul soils on till plains. Included areas make up about 20 percent of the total acreage.

Permeability of this Sulsavar soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of flooding is rare.

This unit is used mainly as woodland and for hay and pasture.

Douglas-fir is the main species on this unit. Based on a 100-year site curve, the mean site index is 183. Based on a 50-year site curve, the mean site index is 141. The mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 194 cubic feet per acre.

Among the trees of limited extent are western hemlock, western redcedar, and red alder. Among the common forest understory plants are western swordfern, red huckleberry, vine maple, ladyfern, and trailing blackberry.

The main limitation for the harvesting of timber is seasonal soil wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Brush competition is the main limitation for timber production. Reforestation can be accomplished by planting Douglas-fir. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. If openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

This unit is suited to hay and pasture. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime.

The main limitation for homesites and septic tank absorption fields is the hazard of flooding. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings and onsite sewage disposal systems from flooding.

This map unit is in capability subclass IVc.

66-Sultan silt loam. This very deep, moderately well drained soil is on flood plains. It formed in alluvium. Areas are 10 to 15 acres in size. The native vegetation is mainly conifers. Elevation is 10 to 120 feet. Slope is 0 to 2 percent. The average annual precipitation is about 45 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 150 to 200 days.

Typically, the surface layer is dark grayish brown silt loam about 12 inches thick. The upper part of the underlying material is dark grayish brown silty clay loam about 30 inches thick. The lower part to a depth of 60 inches or more is olive brown, stratified very fine sandy loam and sand. In some areas the surface layer is silty clay loam or loam or the soil is somewhat poorly drained.

Included in this unit are small areas of Menzel soils on terraces, Puget soils in depressional areas on flood plains, Puyallup soils on stream terraces, and Sultan Variant soils on flood plains. Included areas make up about 15 percent of the total acreage. .

Permeability of this Sultan soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. A seasonal high water table is at a depth of 24 to 48 inches from November to April. Runoff is slow, and the hazard of water erosion is slight. Rare periods of flooding occurs from November to April.

This unit is used mainly as cropland and for hay and pasture. It is also used for homesite development. A few areas are used as woodland.

This unit is suited to use as cropland. Proper row arrangement, field ditches, and vegetated outlets are needed to remove excess water on the surface. Tile drainage can be used to lower the water table if a suitable outlet is available.

A suitable cropping system is one that includes 2 or 3 years of sweet corn and 4 or 5 years of grasses and legumes. Growing an annual crop of vegetables and including an annual winter cover crop to be used as green manure is also a suitable cropping system.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Returning crop residue to the soil and practicing minimum tillage reduce compaction. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is suited to hay and pasture. Grazing when the soil in this unit is wet results in compaction of the surface layer and poor tilth. Open ditch or tile drains can be used for drainage. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime.

This unit is suited to use as woodland. On the basis of a 50-year site curve, the estimated mean site index for red alder is 87. The estimated mean annual increment at culmination (CMAI) for red alder at 40 years of age is 96 cubic feet per acre.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced

roads and skid trails are sticky and slippery when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use.

If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. Reforestation can be accomplished by planting Douglas-fir or western redcedar seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings.

The main limitation for homesites is the hazard of flooding. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings from flooding. Tile drainage around footings reduces wetness. The main limitations for septic tank absorption fields are the seasonal high water table and moderately slow permeability. Use of long absorption lines helps to compensate for the moderately slow permeability. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIw.

67-Sultan Variant silt loam. This very deep, well drained soil is on flood plains. It formed in alluvium. Areas are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 40 to 400 feet. Slope is 0 to 3 percent. The average annual precipitation is about 55 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 150 to 200 days.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is dark grayish brown and olive brown very fine sandy loam and silt loam about 16 inches thick. Below this is olive brown and olive gray loamy fine sand, sand, and coarse sand about 25 inches thick over multicolored very gravelly coarse sand that extends to a depth of 60 inches or more. Depth to loamy fine sand, sand, or very gravelly sand ranges from 20 to 32 inches. In some areas the surface layer is loam or the soil is moderately well drained.

Included in this unit are small areas of Sultan soils, Menzel soils on terraces, and Puyallup soils on stream terraces. Included areas make up about 15 percent of the total acreage.

Permeability of this Sultan Variant soil is moderate in the subsoil and rapid below. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare periods of flooding from November to April.

This unit is used mainly for hay and pasture. It is also used as cropland and for homesite development. A few areas are used as woodland.

This unit is suited to hay and pasture. The main limitation is droughtiness. In some years supplemental irrigation is needed. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime.

This unit is suited to use as cropland. It is limited mainly by droughtiness. In summer irrigation is required for maximum production of most crops. A suitable cropping system is one that includes 2 or 3 years of peas or sweet corn and 3 to 5 years of grasses and legumes. Growing an annual crop of vegetables followed by an annual winter cover crop to be used as green manure is also a suitable cropping system. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables respond to nitrogen, phosphorus, and potassium.

This unit is suited to use as woodland. On the basis of a 50-year site curve, the estimated mean site index for red alder is 85. The estimated mean annual increment at culmination (CMAI) for red alder at 40 years of age is about 92 cubic feet per acre.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are sticky and slippery when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. Reforestation can be accomplished by planting Douglas-fir seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay establishment of seedlings.

The main limitation for homesites is the hazard of flooding. Dikes and channels that have outlets to bypass floodwater can be used to protect onsite sewage disposal systems and buildings from flooding. The main limitations for septic tank absorption fields are seepage and the hazard of flooding. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIs.

68-Sumas silt loam. This very deep soil is on flood plains. The soil is artificially drained. It formed in alluvium. Areas are 5 to 30 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 10 to 500 feet. Slope is 0 to 3 percent. The average annual precipitation is about 45 inches, the average

annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 210 days.

Typically, the surface is dark grayish brown silt loam about 14 inches thick. The upper part of the underlying material is grayish brown and olive gray silt loam and fine sandy loam about 10 inches thick. The lower part to a depth of 60 inches or more is pale yellow sand. Depth to sand ranges from 20 to 32 inches.

Included in this unit are small areas of soils that are somewhat poorly drained. Also included are areas of Mukilteo and Puget soils and Terric Medisaprists in depressional areas; Snohomish, Sultan, and Pilchuck soils on flood plains; and Puyallup soils on stream terraces. Included areas make up about 15 percent of the total acreage.

Permeability of this Sumas soil is moderate to the sand layer and rapid through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 36 inches from November to April. Runoff is slow, and the hazard of water erosion is slight. This soil is partially protected from flooding; however, rare periods of flooding occur from December to March.

This unit is used mainly as cropland and for hay and pasture. A few areas are used as woodland.

This unit is well suited to use as cropland. In summer irrigation is required for maximum production of most crops. A suitable cropping system is one that includes 2 or 3 years of peas or sweet corn and 4 or 5 years of grasses and legumes. An annual crop of vegetables followed by an annual winter cover crop to be used as green manure is also suitable.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Returning crop residue to the soil also reduces crusting of the surface and compaction. Using minimum tillage helps to reduce compaction. Grain and grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

This unit is well suited to hay and pasture. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime. In some years supplemental irrigation is needed.

This unit is suited to use as woodland. On the basis of a 50-year site curve, the estimated mean site index for red alder is 80. The estimated mean annual increment at culmination (CMAI) for red alder at 40 years of age is about 84 cubic feet per acre.

The main limitation for the harvesting of timber is seasonal soil wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are sticky. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

If seed trees are present, natural reforestation of cutover areas by red alder occurs readily. Reforestation can be accomplished by planting western redcedar seedlings. When openings are made in the canopy, invading brushy plants, if not controlled, can delay establishment of seedlings.

The main limitations for homesites are the hazard of flooding and seepage. Cutbanks are not stable and subject to caving in. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings from flooding. Wetness can be reduced by installing drain tile around footings. The main limitations for septic tank absorption fields are the seasonal high water table and seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIw.

69-Terric Medisaprists, nearly level. These very deep, very poorly drained soils are in depressional areas on till plains. They formed in organic material and alluvium. Areas are 10 to 40 acres in size. The native vegetation is mainly conifers and hardwoods. Elevation is 25 to 1,200 feet. Slope is 0 to 3 percent. The average annual precipitation is about 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 180 days.

Typically, the upper layer is black and dark brown organic material 28 inches thick. The substratum to a depth of 60 inches or more is dark brown and very dark gray very gravelly loamy sand. The substratum varies widely in texture, ranging from clay to loamy sand within short distances.

Included in this unit are small areas of soils that have volcanic ash in the profile. Also included are areas of Alderwood and Tokul soils on till plains, Snohomish soils on flood plains, and Mukilteo and Orcas soils in depressional areas on hills. Included areas make up about 15 percent of the total acreage.

Permeability of Terric Medisaprists is moderate. Available water capacity is moderate. Effective rooting depth is limited by the seasonal high water table that is at a depth of 24 to 48 inches where drained. Runoff is ponded, and the hazard of water erosion is slight.

This unit is used mainly for wildlife habitat. Some areas have been drained and are used for hay and pasture or cropland and for homesite development.

If this unit is used for cropland, the main limitation is wetness because of the seasonal high water table. Proper row arrangement, field ditches, and vegetated outlets are needed to remove excess water from the surface. Deep-rooted crops are suited to areas where

the drainage is adequate or where a drainage system has been installed. Tile drainage can be used to lower the water table if a suitable outlet is available. Subsidence is minimized if the water table is maintained immediately below the root zone and allowed to return to the surface outside the growing season. In summer irrigation is required for maximum production of most crops.

A suitable cropping system is one that includes 1 or 2 years of peas or sweet corn and 3 or 4 years of grasses and legumes. An annual crop of vegetables followed by an annual winter cover crop to be used as green manure is also suitable. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grasses respond to nitrogen; legumes respond to phosphorus, boron, sulfur, and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium.

If this unit is used for hay and pasture, the main limitation is wetness because of the seasonal high water table. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. Excessive water can be removed by open ditch or tile drainage if adequate outlets are available. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime. In some years supplemental irrigation is needed.

The main limitation for homesites and septic tank absorption fields is wetness. Where outlets are available, excess water can be removed by using shallow ditches. Wetness can be reduced by installing drain tile around footings. Septic tank absorption fields often fail or do not function properly during the rainy season.

This map unit is in capability subclass IIw.

70-Tokul silt loam, 2 to 8 percent slopes. This moderately deep, moderately well drained soil is on till plains. It formed in glacial till and volcanic ash. Areas are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown silt loam about 12 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 10 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is gravelly loam or the soil does not have a hardpan but is underlain by compact glacial till at a depth of 20 to 40 inches.

Included in this unit are small areas of Pastik soils on terraces. Included areas make up about 25 percent of the total acreage.

Permeability of this Tokul soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland and for hay and pasture. It is also used for homesite development.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet per acre for Douglas-fir at age 60 and 266 cubic feet per acre for western hemlock at age 50. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, red huckleberry, salal, and trailing huckleberry.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by Douglas-fir and red alder occurs readily and natural reforestation by western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the hardpan, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This unit is suited to hay and pasture. The main limitations are wetness and depth to the hardpan, which reduces the yield of deep-rooted plants. Excess water can be removed by open ditches or tile drains if a suitable outlet is available. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and

fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime. In some years supplemental irrigation is needed. Subsoiling may be effective in breaking through the hardpan.

The main limitation for homesites is the seasonal high water table. Wetness can be reduced by installing drain tile around footings. The main limitations for septic tank absorption fields are the depth to the hardpan and wetness. Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

This map unit is in capability subclass IIIe.

71-Tokul silt loam, 8 to 15 percent slopes. This moderately deep, moderately well drained soil is on till plains. It formed in glacial till and volcanic ash. Areas are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown silt loam about 12 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 10 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is gravelly loam or the soil does not have a hardpan but is underlain by glacial till at a depth of 20 to 40 inches.

Included in this unit are areas of Pastik soils on terraces. Included areas make up about 25 percent of the total acreage.

Permeability of this Tokul soil is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is medium, and hazard of water erosion is moderate.

This unit is used mainly as woodland and for hay and pasture. It is also used for homesite development.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet for Douglas-fir at age 60 and 266 cubic feet per acre for western hemlock at age 50.

Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, red huckleberry, salal, and trailing blackberry.

The main limitation for the harvesting of timber is seasonal soil wetness, which restricts the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and natural reforestation by western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the hardpan, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This unit is suited to hay and pasture. The main limitations are wetness and the hardpan, which reduces the yield of deep-rooted plants. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime. In some years supplemental irrigation is needed. Subsoiling may be effective in breaking through the hardpan.

The main limitation for homesites is the seasonal high water table. Wetness can be reduced by installing drain tile around footings. The main limitations for septic tank absorption fields are the depth to the hardpan and wetness. Onsite sewage disposal systems often fail or do not function properly during the periods of high rainfall because of the restrictive layer.

This map unit is in capability subclass IIIe.

72-Tokul gravelly loam, 0 to 8 percent slopes. This moderately deep, moderately well drained soil is on till plains. It formed in glacial till and volcanic ash. Areas are long and narrow and are oriented from northwest to southeast. They are 40 to 100 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam

about 9 inches thick. A hardpan is at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is cobbly loam or the soil does not have a hardpan but is underlain by compact glacial till at a depth of 20 to 40 inches.

Included in this unit are areas of soils that have slopes of more than 8 percent, McKenna and Norma soils in depressional areas along drainageways on till plains, Terric Medisaprists in depressional areas on till plains, Winston and Pastik soils on terraces and outwash plains, and Ragnar soils on outwash plains. Included areas make up about 25 percent of the total acreage.

Permeability of this Tokul soil is moderate above the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used for urban development and for hay and pasture.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet per acre for Douglas-fir at age 60 and 266 cubic feet per acre for western hemlock at age 50.

Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, red huckleberry, salal, and trailing blackberry.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Brush competition is the main limitation in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and natural reforestation by western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the hardpan, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitations for hay and pasture are wetness and the depth to the hardpan, which reduces the yield of deep-rooted plants. Excess water can be removed by open ditches or tile drains. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime. In some years supplemental irrigation is needed. Small stones may interfere with tillage operations. Subsoiling may be effective in breaking through the hardpan.

The main limitation for homesites is wetness, which can be reduced by installing drain tile around footings.

The main limitations for septic tank absorption fields are the depth to the hardpan and wetness. Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

This map unit is in capability subclass IIIe.

73-Tokul gravelly loam, 8 to 15 percent slopes. This moderately deep, moderately well drained soil is on till plains. It formed in glacial till and volcanic ash. Areas are oriented from northwest to southeast and are 40 to 100 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is cobbly or the soil does not have a hardpan but is underlain by compact glacial till at a depth of 20 to 40 inches.

Included in this unit are small areas of Pastik and Winston soils on terraces and outwash plains; Nargar soils on high terraces, terrace escarpments, and outwash plains; and Ragnar soils on outwash plains. Included areas make up about 25 percent of the total acreage.

Permeability of this Tokul soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used for homesite development and for hay and pasture.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year

site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet per acre for Douglas-fir at age 60 and 266 cubic feet per acre for western hemlock at age 50.

Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, red huckleberry, salal, and trailing blackberry.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and natural reforestation by western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the hardpan, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This unit is suited to hay and pasture. The main limitations are wetness because of the seasonal perched water table and depth to the hardpan, which reduces the yield of deep-rooted plants. Excess water can be removed by open ditches or tile drains. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. Legumes benefit from applications of agricultural lime. In some years supplemental irrigation is needed. Small stones may interfere with tillage. Subsoiling may be effective in breaking through the hardpan.

The main limitation for homesites is the seasonal perched water table. Wetness can be reduced by installing drain tile around footings.

The main limitations for septic tank absorption fields are the depth to the hardpan and wetness. Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall.

This map unit is in capability subclass IIIe.

74-Tokul gravelly loam, 15 to 25 percent slopes. This moderately deep, moderately well drained soil is on till plains. If formed in glacial till and volcanic ash. Areas are oriented from northwest to southeast and are 40 to 100 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches. In some areas the surface layer is cobbly or the soil does not have a hardpan but is underlain by compact glacial till at a depth of 20 to 40 inches.

Included in this unit are areas of McKenna and Norma soils in depressional areas along drainageways on till plains, Terric Medisaprists in depressional areas on till plains, Winston and Pastik soils on terraces and outwash plains, and Ragnar soils on outwash plains. Included areas make up about 25 percent of the total acreage.

Permeability of this Tokul soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It is also used for homesite development.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet per acre for Douglas-fir at age 60 and 266 cubic feet per acre for western hemlock at age 50.

Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common forest understory plants are western swordfern, brackenfern, red huckleberry, salal, and trailing blackberry.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment to dry periods. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and that of western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the hardpan, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitation for homesites is the seasonal high water table. Wetness can be reduced by installing drain tile around footings. The main limitations for septic tank absorption fields are steepness of slope, wetness, and depth to the hardpan. Onsite sewage disposal systems often fail or do not function properly during periods of high rainfall because of the pan. Access roads must be designed to control surface runoff and help stabilize cut slopes.

This map unit is in capability subclass IVe.

75-Tokul-Ogarty-Rock outcrop complex, 0 to 25 percent slopes. This map unit is on till plains and foothills. Areas are irregular in shape and 25 to 80 acres in size. The native vegetation is mainly conifers. Elevation is 350 to 1,000 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 180 days.

This unit is about 60 percent Tokul silt loam, about 20 percent Ogarty very gravelly loam, and about 10 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Nargar, Pastik, and Winston soils on terraces and outwash plains, Ragnar soils on outwash plains, and Terric Medisaprists in depressional areas on till plains. Also included are some areas of soils that do not have a hardpan but are underlain by compact glacial till at a depth of 20 to 40 inches. Included areas make up about 10 percent of the total acreage.

The Tokul soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Tokul soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is medium, and the hazard of water erosion is moderate.

The Ogarty soil is moderately deep and moderately well drained. It formed in volcanic ash and glacial till derived dominantly from andesite. Typically, the surface is covered with a mat of litter and decomposed material about 2 inches thick. The surface layer, where mixed to a depth of about 6 inches, is dark brown very gravelly loam. The subsoil is dark brown very gravelly loam and brown extremely gravelly loam about 26 inches thick. The substratum is dark brown and yellowish red extremely gravelly loam about 6 inches thick. Andesite is at a depth of about 38 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Ogarty soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

Rock outcrop consists of areas where 90 percent of the surface is exposed andesite or argillite. It occurs as very steep cliffs.

This unit is used mainly as woodland.

Douglas-fir and western hemlock are the main woodland species on the Tokul soil. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet per acre for Douglas-fir at age 60 and 266 cubic feet per acre for western hemlock at age 50.

Douglas-fir and western hemlock are also the main woodland species on the Ogarty soil. On the basis of a 100-year site curve, the mean site index is 150 for Douglas-fir and 176 for western hemlock. On the basis of a 50-year site curve, the mean site index is 117 for Douglas-fir and 115 for western hemlock. The mean annual increment at culmination (CMAI) is 158 cubic feet per acre for Douglas-fir at age 60 and 285 cubic feet per acre for western hemlock at age 50. The areas of Rock outcrop in this unit reduce yield by about 10 percent.

Among the trees of limited extent on this unit are western redcedar, red alder, Pacific silver fir, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, red huckleberry, salal, and trailing blackberry.

The main limitation for the harvesting of timber is seasonal soil wetness, which limits the use of equipment on the Tokul soil. The areas of Rock outcrop hinder yarding operations. Use of wheeled and tracked equipment when the soil is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Establishing

plant cover on steep road cut and fill slopes reduces erosion. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and that of western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation. Rock outcrop limits the even distribution of reforestation.

Because the rooting depth is restricted by the hardpan and underlying bedrock, trees are subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitation for septic tank absorption fields and homesites is the steepness of slope in areas where slopes are more than 15 percent. Rock outcrop may interfere with the placement of septic tank absorption lines. On the Tokul soil a seasonal high water table is perched above the hardpan; thus, drainage is needed if buildings with basements and crawl spaces are constructed. On the Ogarty soil deep cuts can expose bedrock.

This map unit is in capability subclass Vle.

76-Tokul-Ogarty-Rock outcrop complex, 25 to 65 percent slopes. This map unit is on till plains and foothills. Areas are irregular in shape and are 40 to 100 acres in size. The native vegetation is mainly conifers. Elevation is 500 to 1,000 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 180 days.

This unit is about 50 percent Tokul gravelly loam, about 25 percent Ogarty very gravelly loam, and about 10 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used. In some areas the soil does not have a hardpan but is underlain by compact glacial till at a depth of 20 to 40 inches.

Included in this unit are small areas of Elwell and Olomount soils on mountainsides and ridgetops, Pastik and Winston soils on terraces and outwash plains, and talus slopes below areas of Rock outcrop. Included areas make up about 15 percent of the total acreage.

The Tokul soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Tokul soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is rapid, and the hazard of water erosion is high.

The Ogarty soil is moderately deep and moderately well drained. It formed in volcanic ash and glacial till derived dominantly from andesite. Typically, the surface is covered with a mat of litter and decomposed material about 2 inches thick. The surface layer, where mixed to a depth of about 6 inches, is dark brown very gravelly loam. The subsoil is dark brown very gravelly loam and brown extremely gravelly loam about 26 inches thick. The substratum is dark brown and yellowish red extremely gravelly loam about 6 inches thick. Andesite is at a depth of about 38 inches. Depth to andesite ranges from 20 to 40 inches.

Permeability of the Ogarty soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is high.

Rock outcrop consists of areas where 90 percent of the surface is exposed andesite or argillite. It occurs as steep cliffs.

This unit is used mainly as woodland.

Douglas-fir and western hemlock are the main woodland species on the Tokul soil. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet per acre for Douglas-fir at age 60 and 266 cubic feet per acre for western hemlock at age 50.

Douglas-fir and western hemlock are also the main woodland species on the Ogarty soil. On the basis of a 100-year site curve, the mean site index is 150 for Douglas-fir and 176 for western hemlock. On the basis of a 50-year site curve, the mean site index is 117 for Douglas-fir and 115 for western hemlock. The mean annual increment at culmination (CMAI) is 158 cubic feet per acre for Douglas-fir at age 60 and 285 cubic feet per acre for western hemlock at age 50.

Rock outcrop in this unit reduces yield by about 10 percent.

Among the trees of limited extent in this unit are western redcedar, red alder, bigleaf maple, and Pacific silver fir. Among the common forest understory plants are western swordfern, brackenfern, red huckleberry, salal, and trailing blackberry.

The main limitation for the harvesting of timber is the steepness of slope, which restricts the use of wheeled and tracked equipment in skidding operations. Use of cable yarding systems on the steeper parts of this unit generally is safer and disturbs the soil less. Rock

outcrop may hinder yarding operations. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit.

The seasonal perched water table of the Tokul soil limits the use of equipment. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or they are protected by plant cover. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and that of western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent the establishment of conifer seedlings. Rock outcrop limits the even distribution of reforestation.

Because the rooting depth is restricted by the hardpan and underlying bedrock, trees are occasionally subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This map unit is in capability subclass VIIe.

77-Tokul-Winston gravelly loam, 25 to 65 percent slopes. This map unit is on till plains and terrace escarpments. Areas are irregular in shape and are 20 to 160 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 900 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

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

Included in this unit are soils that are similar to the Tokul soil but do not have a hardpan; however, they are underlain by compact glacial till at a depth of 20 to 40 inches. Also included are small areas of Pastik soils on terraces and Ragnar soils on outwash plains. Included areas make up about 20 percent of the total acreage.

The Tokul soil is moderately deep and moderately well drained. It formed in glacial till and volcanic ash. Typically, the surface is covered with a mat of leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 4 inches thick. The subsoil is brown, strong brown, and dark yellowish brown gravelly loam about 18 inches thick. The substratum is light olive brown gravelly fine sandy loam about 9 inches thick. A hardpan is at a depth of about 31 inches. Depth to the hardpan ranges from 20 to 40 inches.

Permeability of the Tokul soil is moderate to the hardpan and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 18 to 36 inches from November to May. Runoff is rapid, and the hazard of water erosion is high.

The Winston soil is very deep and somewhat excessively drained. It formed in glacial outwash and volcanic ash. Typically, the surface is covered with a mat of needles, leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 3 inches thick. The subsoil is dark brown, strong brown, and yellowish brown gravelly loam and gravelly fine sandy loam about 13 inches thick. The upper part of the substratum is yellowish brown gravelly fine sandy loam about 9 inches thick. The lower part to a depth of 60 inches or more is very dark grayish brown extremely gravelly coarse sand.

Permeability of the Winston soil is moderate to the lower part of the substratum and very rapid through it. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is high.

This unit is used mainly as woodland.

Douglas-fir and western hemlock are the main woodland species on the Tokul soil. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. The mean annual increment at culmination (CMAI) is 184 cubic feet per acre for Douglas-fir at age 60 and 266 cubic feet per acre for western hemlock at age 60.

Douglas-fir and western hemlock are also the main woodland species on the Winston soil. On the basis of a 100-year site curve, the mean site index is 167 for Douglas-fir and 164 for western hemlock. On the basis of a 50-year site curve, the mean site index is 127 for Douglas-fir and 104 for western hemlock. The mean annual increment at culmination (CMAI) is 178 cubic feet per acre for Douglas-fir at age 60 and 262 cubic feet per acre for western hemlock at age 60.

Among the trees of limited extent on this unit are western redcedar, red alder, and bigleaf maple. Among the common forest understory plants are western swordfern, brackenfern, red huckleberry, salal, and trailing blackberry.

The main limitations for the harvesting of timber are seasonal soil wetness and steepness of slope. The seasonal perched water table in the Tokul soil limits the use of equipment to dry periods. When harvesting timber, steep slopes restrict the use of wheeled and tracked equipment in skidding operations. Use of cable yarding systems on the steeper. parts of this unit generally is safer and disturbs the soil less. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars

are provided or they are protected by plant cover. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Brush competition is the main limitation for the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and that of western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

Because the rooting depth is restricted by the hardpan in the Tokul soil, trees are subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

This map unit is in capability subclass VIIe.

78-Urban land. This map unit consists of nearly level to gently sloping areas covered by streets, buildings, parking lots, and other structures that obscure or alter the soils so that identification is not feasible. Areas are 10 to 50 acres in size. Elevation is 50 to 450 feet. The average annual precipitation is about 40 inches. The mean annual air temperature is about 52 degrees F, and the average frost-free season is about 200 days.

Included in this unit are small areas of Alderwood, Everett, and Tokul soils.

This map unit is not assigned a capability classification.

79-Verlot mucky silt loam, 3 to 25 percent slopes. This moderately deep, moderately well drained soil is on mountainsides and ridgetops. It formed in glacial till and volcanic ash. Areas are 30 to 100 acres in size. The native vegetation is mainly conifers. Elevation is 2,800 to 4,000 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free season is 90 to 100 days.

Typically, the surface is covered with a mat of partially decomposed leaves, twigs, and needles about 2 inches thick. The surface layer is black mucky silt loam about 10 inches thick. The subsurface layer is brown silt loam about 6 inches thick. The subsoil is reddish brown and dark brown silt loam and gravelly loam about 19 inches thick. Olive brown, dense glacial till is at a depth of about 35 inches. Depth to glacial till ranges from 20 to 40 inches.

Included in this unit are small areas of Cryohemists, nearly level, in depressional areas on high mountain ridgetops. Also included are small areas of Getchell, Hartnit, Oso, and Potchub soils on mountainsides and ridgetops. Included areas make up about 15 percent of the total acreage.

Permeability of this Verlot soil is moderate to the glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is limited by a seasonal perched water table that is at a depth of 12 to 36 inches from November to May. Runoff is slow, and the hazard of water erosion is slight. The effect of the layer of dense glacial till on use and management is similar to that of a hardpan.

This unit is used mainly as woodland and watershed.

Western hemlock and Pacific silver fir are the main woodland species on this unit. On the basis of a 100year site curve, the mean site index for western hemlock is 85. On the basis of a 50-year site curve, the mean site index is 60. The estimated mean annual increment at culmination (CMAI) for western hemlock at age 60 is about 97 cubic feet per acre. Estimates of site index and yield for Pacific silver fir have not been made. Among the common forest understory plants are red huckleberry, blue-leaved huckleberry, and trailing blackberry.

The main limitation for harvesting of timber is seasonal soil wetness. A seasonal perched water table limits the use of equipment to dry periods. Snowpack also restricts the use of equipment and limits access. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are sticky when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit.

Seedling establishment and windthrow hazard are the main concerns for the production of timber. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of natural reforestation.

Because the rooting depth is restricted by the underlying glacial till and the seasonal perched water table, trees are subject to windthrow. Western hemlock, a shallow-rooted tree, is more commonly subject to windthrow than are more deeply rooted trees.

The main limitations for homesites are wetness and steepness of slope in areas where slope is more than 15 percent. Water erosion is a hazard in the steeper areas. Only the part of the site that is used for construction should be disturbed. A seasonal high water table is perched above the glacial till, and drainage is needed if buildings with basements and crawl spaces are constructed. Foundations for dwellings require special design to overcome the risk of frost damage.

The main limitations for septic tank absorption fields are depth to the glacial till, wetness, and steepness of slope in areas where the slope is more than 15 percent. Septic tank absorption lines should be installed on the contour.

This map unit is in capability subclass VIIe.

80-Winston gravelly loam, 0 to 3 percent slopes. This very deep, somewhat excessively drained soil is on terraces and outwash plains. It formed in glacial outwash

and volcanic ash. Areas are 20 to 60 acres in size. The larger areas are along major drainageways. The native vegetation is mainly conifers. Elevation is 200 to 900 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 48 degrees F., and the average frost-free season is 140 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 3 inches thick. The subsoil is dark brown, strong brown, and yellowish brown gravelly loam and gravelly fine sandy loam about 13 inches thick. The upper part of the substratum is yellowish brown gravelly fine sandy loam about 9 inches thick. The lower part to a depth of 60 inches or more is very dark grayish brown extremely gravelly coarse sand. In some areas the subsoil is very gravelly sandy loam.

Included in this unit are areas of soils that have slopes of more than 3 percent, Pastik soils on terraces, Ragnar soils on outwash plains, Sulsavar soils on terraces and alluvial fans, Tokul soils on till plains, and Rock outcrop. Included areas make up about 15 percent of the total acreage.

Permeability of this Winston soil is moderate to the lower part of the substratum and very rapid through it. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used for hay and pasture and for homesite development.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 167 for Douglas-fir and 164 for western hemlock. On the basis of a 50-year site curve, the mean site index is 127 for Douglas-fir and 104 for western hemlock. The mean annual increment at culmination (CMAI) is 178 feet per acre for Douglas-fir at age 60 and 262 cubic feet per acre for western hemlock at age 50.

Among the trees of limited extent are western redcedar and red alder. Among the common forest understory plants are western swordfern, red huckleberry, western brackenfern, salal, and trailing blackberry.

The main limitation for harvesting timber is seasonal soil wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit.

Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and that of western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

The main limitations for hay and pasture are low available water capacity and small stones, which can interfere with cultivation. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. In most years supplemental irrigation is also needed. Fertilizer is needed for optimum growth of grasses and legumes.

This unit is suited to homesite development. The main limitation for septic tank absorption fields is seepage. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage.

This map unit is in capability subclass IIIs.

81-Winston gravelly loam, 3 to 30 percent slopes. This very deep, somewhat excessively drained soil is on terraces, terrace escarpments, and outwash plains. It formed in glacial outwash and volcanic ash. Areas are 5 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 200 to 900 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and decomposed litter about 2 inches thick. The surface layer is dark brown gravelly loam about 3 inches thick. The subsoil is dark brown, strong brown, and yellowish brown gravelly loam and gravelly fine sandy loam about 13 inches thick. The upper part of the substratum is yellowish brown gravelly fine sandy loam about 9 inches thick. The lower part to a depth of 60 inches or more is very dark grayish brown extremely gravelly coarse sand. Some areas have a very gravelly sandy loam subsoil.

Included in this unit are small areas of Pastik soils on terraces, Ragnar soils on outwash plains, Sulsavar soils on terraces and alluvial fans, Tokul soils on till plains, and Rock outcrop. Included areas make up about 15 percent of the total acreage.

Permeability of this Winston soil is moderate to the lower part of the substratum and very rapid through it. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 167 for Douglas-fir and 164 for western hemlock. On the basis of a 50-year site curve, the mean site index is 127 for Douglas-fir and 104 for western hemlock. The mean annual increment at culmination (CMAI) is 178 cubic feet per acre for Douglas-fir at age 60 and 262 cubic feet per acre for western hemlock at age 50. Among the trees of limited extent are western redcedar and red alder. Among the common forest understory plants are western swordfern,

red huckleberry, western brackenfern, salal, and trailing blackberry.

The main limitation for harvesting of timber is seasonal soil wetness. Use of wheeled and tracked equipment when the soil in this unit is wet produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet, and they may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Establishing plant cover on steep road cut and fill slopes reduces erosion.

Brush competition is the main limitation in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by red alder occurs readily and that of western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants, if not controlled, can prevent reforestation.

The main limitation for homesites is steepness of slope in areas where slopes are more than 15 percent. The main limitations for septic tank absorption fields are seepage and steepness of slope in areas where the slopes are more than 15 percent. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVe.

82-Xerorthents, level. This map unit is on till plains. Most areas are 5 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 5 to 1,000 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

This unit consists of areas where the surface layer, subsoil, and substratum have been greatly disturbed, removed, or replaced with other soil material. Properties are highly variable within short distances.

Included in this unit are small areas of Alderwood, Tokul, and Indianola soils. Also included are areas of debris, such as wood chips from lumber mills.

This unit is used mainly for unpaved parking areas, fill sites, mobile home parks, athletic fields, and other urban uses.

Onsite inspection of areas of this unit is necessary to determine their suitability for intended uses. This map unit is in capability subclass VIIs.

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 86,000 acres of Snohomish County Area is used as cropland, most of which is pasture for livestock (16). Potatoes, corn, wheat, barley, rhubarb, raspberries, and blueberries are grown in areas that are drained or where natural drainage is adequate. Wetness, low soil fertility, and the hazard of erosion are the main management concerns.

The McKenna soils in this survey area have a layer of dense glacial till at a depth of 20 to 40 inches. This glacial till restricts movement of roots and water and has an effect on use and management similar to that of a hardpan.

The Indianola, Lynnwood, and Puyallup soils that have slopes of less than 6 percent are well suited to vegetables and small fruits. If adequately drained, the mucky soils in this survey area are well suited to vegetables and berries.

The hazard of erosion is a concern on the Kitsap, Pastik, and Rober soils that have slopes of more than 2 percent. Loss of the surface layer reduces fertility and productivity. Practices to control erosion that provide a protective surface cover, reduce runoff, and increase the water infiltration rate are needed.

Soil drainage is needed on about two-thirds of the acreage used for crops and pasture. Unless the soils are artificially drained, production of cultivated crops generally is not feasible. The poorly drained soils in the survey area are the Bellingham, Custer, McKenna, Norma, Puget, and Sumas soils; the organic Mukilteo muck; and Terric Medisaprists.

Proper design of both surface and subsurface drainage systems varies with each kind of soil. A combination of surface and tile drains is needed in most areas of the poorly drained and very poorly drained soils. Adequate outlets for tile drainage systems are difficult to locate on the Bellingham, Custer, McKenna, and Norma soils.

Organic soils oxidize and subside when the pores are filled with air; thus, special drainage systems are required to control the depth and period of drainage. Keeping the water table at the proper level for crops during the growing season and raising it to the surface during other times of the year minimize the oxidation and subsidence of organic soils.

The soils on uplands have low fertility, and they are not so productive as the soils on flood plains. For good growth of alfalfa and other crops, applications of lime are needed to raise the soil reaction to about neutral. Levels of available phosphorus and potash are low in most of the soils on uplands.

Information on the proper design of erosion control practices and drainage systems for each kind of soil in the survey area is available at the local office of the Soil Conservation Service. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops (18). Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, e, w, s, or c, to the class numeral, for example, IIe. The letter e shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; w shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); s shows that the soil is limited mainly because it is shallow, droughty, or stony; and c, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by w, s, or c because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed soil map units."

woodland management and productivity

By Dennis J. Robinson and Robert Whitefield, foresters, and Shirley E. Perry, biological technician, Soil Conservation Service.

A large part of the survey area is forested. The forest land is owned and managed mainly by forest industry corporations and private, nonindustrial owners (5). The forested land totals about 487,000 acres, of which about 11,000 acres, stocked mainly with hardwood species, is controlled by the Tulalip Indians.

There are 21 softwood sawmills, 5 hardwood sawmills, 33 specialty sawmills, and 3 post and piling outlets in the survey area (6). Both high grade and low grade paper products for use throughout the county and state are manufactured from wood chips.

The forest industry has begun using more intensive management practices for the forest land in the survey area. Management of the nonindustrial areas is also improving as a result of the use of conservation programs.

Historically, the native stands of trees in the survey area were primarily conifers; however, deciduous trees now grow on a significant part of the acreage. Douglas-fir and western hemlock are the dominant conifers, but significant numbers of western redcedar also occur. Old growth redcedar is in great demand for specialty products, but only a few areas of western redcedar are being established by public and private woodland managers.

Red alder is the main deciduous tree in the survey area. It grows in pure stands and in stands mixed with other deciduous and coniferous species. Red alder commonly invades logged-off areas, and it becomes dominant unless intensive management practices are used. A barren mineral soil, an adequate seed source, and an abundant supply of moisture are needed for establishment of red alder.

Soils vary in their ability to produce wood fiber. Depth to a restrictive layer, soil fertility, texture, and available water capacity influence growth. Elevation, aspect, the kind of soil, and climate determine the kinds of trees that can be grown on a given site.

Woodland management of coniferous species is concentrated in areas that are at intermediate to high elevations. These areas are well stocked with pure stands of hardwoods or mixed stands of hardwoods and conifers.

The large valleys of rivers that flow east to west, such as the Stillaguamish and Skykomish Rivers, act as warm air funnels. They collect and trap warm air from the prevailing westerly winds during the winter. As a result of this, pure stands of Douglas-fir can be established in areas further to the east that have higher precipitation, are at a higher elevation, and are cooler. These areas otherwise would be suitable only for western hemlock.

Pure stands of western hemlock and mixed stands of western hemlock, Douglas-fir, and western redcedar are in areas further to the east at higher elevations. Western hemlock persists because of its ability to regenerate under a closed canopy and its proliferate seed production. Still further east, where the elevation and available moisture increase and the growing season decreases, stands of western hemlock and Pacific silver fir occur. Stands of Pacific silver fir and mountain hemlock are at elevations of more than 2,800 feet. Regeneration of most species is difficult at these higher elevations, and Pacific silver fir commonly is the only species that can become established in significant amounts.

Soil surveys are becoming increasingly more important to woodland managers as they seek ways of increasing the productivity of forest land. Some soils respond better to fertilization, some are more susceptible to landslides and erosion after roadbuilding and harvesting of trees, and some require special management for harvesting and reforestation.

In the section "Detailed soil map units" of this survey, each map unit suitable for producing wood crops gives information on woodland productivity, common forest understory plants, limitations for harvesting timber, and concerns for producing timber. Table 6 summarizes the forestry information given in these map units, and it can be used as a reference for important woodland interpretations. The table lists the map unit symbol and the ordination (woodland suitability) symbol for each soil. Soils that have the same ordination symbol require the same general woodland management and have about the same potential productivity.

The first part of the *ordination symbol,* a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, 6, and 7, low. This number corresponds to the 50-year site curve indexes established for Douglas-fir, red alder, and western hemlock. The second part of the symbol, a letter, indicates the major kind of soil limitation for tree growth and management. The letter *w* indicates excessive water in or on the soil; *d*, restricted rooting depth; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that few if any limitations or restrictions are significant.

In table 6 the soils are rated for a number of factors to be considered in management. *Slight, moderate,* and *severe* are used to indicate the degree of the major soil limitations.

Equipment limitation ratings refer to the soil characteristics that restrict year-round or seasonal use of equipment. A rating of *slight* indicates that use is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation because of soil wetness, a fluctuating water table, or some other factor; and *severe* indicates a seasonal limitation, a need for special equipment such as a cable yarding system, or a hazard in the use of equipment.

Steepness of slope and soil wetness are the main limitations for use of equipment. As the slope becomes steeper and longer, use of wheeled equipment becomes more difficult, and only tracked equipment is suitable for use in some areas. On the steepest slopes, even tracked equipment does not operate safely, and more sophisticated systems are needed. Soil wetness, especially in combination with fine texture, can severely limit the use of equipment and make harvesting practical only during the dry summer months.

Seedling mortality ratings refer to the probability of death of natural or planted tree seedlings as influenced by the kinds of soil and topography. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted or to natural regeneration during a period of sufficient soil moisture.

A rating of *slight* indicates that no problem of mortality is expected under normal conditions; *moderate* indicates that some problems can be expected and extra precautions are advisable; and *severe* indicates that mortality is high and extra precautions are essential for successful reforestation. Soil wetness; droughtiness of the surface layer, especially on south- and southwest-facing slopes; and areas of soils on ridgetops are concerns for seedling mortality. Larger than normal planting stock, special site preparation, surface drainage, or reinforcement planting may be needed to overcome these limitations.

Windthrow hazard ratings are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. Restricted rooting depth because of the high water table and the underlying bedrock or poor anchoring of roots because of a loose surface layer and subsoil result in windthrow. A rating of *slight* indicates that trees normally are not blown down or uprooted by wind, but strong winds may break trees; *moderate,* some trees are blown down during periods of excessive wetness and strong winds; and *severe,* many trees are blown down during periods of soil wetness and moderate or strong winds. If the windthrow hazard rating is moderate or severe, care in thinning the edges of woodland stands, periodic salvage of windthrown trees, and adequate roads and trails for salvage operations are needed.

Plant competition ratings refer to the probability of the invasion of brushy plants where there are openings in the tree canopy. A rating of *slight* indicates that unwanted brushy plants are not likely to delay natural reforestation or restrict the development of planted seedlings; *moderate* indicates that competition will delay reforestation by native plants or planted seedlings; and *severe* indicates that competition is expected to prevent reforestation. If the rating is moderate or severe, careful and thorough cleanup after harvesting is needed to prepare the soil for reforestation and mechanical or chemical brush treatment may be needed to retard the growth of brush and allow seedlings to develop.

A favorable climate and productive soils encourage plant competition. Generally, the hazard of brush invasion is lower at higher elevations. In many areas the extent of plant competition can be predicted by determining the quantity and proximity of seed sources of undesirable plants.

The *potential productivity* of *common trees* on a soil is expressed as *a site index.* This index is determined by taking height and age measurements of selected trees in stands of a given species. The "50-year site curve" index is given in table 6. Both the "50-year site curve" index and the "100-year site curve" index are given in the section "Detailed soil map units." The procedure and technique for calculating the site indexes are given in the site index tables used for this survey area (*4, 12, 13, 21, 22*). The site index applies to fully stocked, even-aged, unmanaged stands of trees. The highest timber yields, expressed in board feet or cubic feet per acre, can be expected from soils that have the highest site indexes. Site indexes can be converted into estimated yields at various ages by using the appropriate yield table (7, *8,* 9). Common trees are listed in the order of their dominance on the soils. Generally, only one or two woodland species are dominant.

Trees to plant are those that are used for reforestation or natural regeneration. Species listed are suited to the soils and to commercial wood production.

recreation

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example,

interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

By Ivan L. Lines, Jr., biologist, Soil Conservation Service.

Snohomish County Area has a wide variety of wildlife habitat that supports many species of wildlife. It varies from saltwater tidelands and shorelines on the Puget Sound to alpine plant communities along the crest of the Cascade Range. Elevation of these areas ranges from sea level to more than 10,000 feet.

Several miles of saltwater shorelines and thousands of acres of tidelands provide habitat for oysters, clams, crabs, and numerous saltwater and freshwater fish. Many species of waterfowl and shorebirds, such as brant, wigeon, gulls, sandpipers, and plovers, also use these areas.

Farming on most of the fertile soils on lowlands, along flood plains, and in many upland areas provides habitat for openland wildlife such as pheasant, California quail, and rabbits. These areas also commonly supply some habitat for woodland wildlife and waterfowl.

Much of the uplands in the area are covered by extensive stands of Douglas-fir and red alder, and the wet soils and riparian corridors support bigleaf maple, cottonwood, and dogwood. These woodland areas have a diverse understory of salal, Oregon-grape, huckleberry, and rhododendron. The areas provide habitat for woodland wildlife such as black-tailed deer, black bear, woodpeckers, ruffed grouse, and mountain beaver. They also provide food and cover for birds and mammals that mainly feed in forest openings and on cropland.

Numerous lakes and farm ponds support trout and warmwater fish. Most of the streams that flow into the Puget Sound once contained large runs of salmon, steelhead, and sea-run cutthroat trout. Some of the runs have been eliminated or reduced, but many streams still support some anadromous fish.

The city of Everett and the proximity of the survey area to the Seattle metropolitan area have resulted in increased urban, suburban, and recreational development. This development and the timber production and farming activities in the area have a great impact on wildlife habitat. Few of the soils in the area are managed specifically for wildlife habitat; therefore, management of the soils used mainly for other purposes largely determines the amount and quality of habitat and the abundance of wildlife.

Proper management of the cropland and hay and pasture on general soil map units 1, 2, and 3 can enhance wildlife habitat. Suitable practices are planting cover crops; returning crop residue to the soil; leaving strips of undisturbed vegetation along shorelines and streambanks; proper handling of livestock waste to prevent pollution of water; and proper handling of pesticides and chemicals.

Some soils in the area are poorly drained and are suited to the development of ponds and wetland areas. Practices such as building dikes, water control structures, and islands can create or improve wetland wildlife habitat.

Use of suitable management practices in the woodland areas of units 2, 3, 4, 5, and 6 can also enhance wildlife habitat. Small-scale clearcutting helps to create a diversity of successional stages in the vegetation, which results in a wide variety of wildlife habitat. Leaving strips of undisturbed vegetation along stream corridors and shorelines helps to prevent pollution of water sources and destruction of aquatic habitat, and these strips of riparian vegetation can be used as habitat for wildlife. Leaving snags standing provides habitat for cavity nesting birds and provides food for all types of wildlife. Logging practices that

reduce erosion and prevent sediment and debris from entering streams should be used. Disturbed areas, such as roads, skid trails, and burns, need to be seeded to grasses and legumes to reduce water pollution.

Increasing acreages of the soils in units 1, 2, and 3 are being used for urban development, and careful planning is needed to preserve as much wildlife habitat as possible. Landscaping urban areas can beautify the areas as well as provide habitat for wildlife. Control of sediment from construction sites is needed to prevent disturbance of adjacent areas and water pollution. Proper disposal systems for sewage, storm runoff, and other possibly harmful pollutants is also needed. Strips of riparian vegetation should be maintained to prevent streambank erosion, intercept sediment, and provide areas of wildlife habitat.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, orchardgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are western swordfern, western brackenfern, pacific trillium; and fireweed.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are Pacific fir, western hemlock, noble fir, and western red cedar.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are salal; red huckleberry, Oregon grape, salmonberry, snowberry, and blackberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, cattail, saltgrass, rushes, sedges and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include California quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and

associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, thrushes, woodpeckers, squirrels, gray fox, raccoon, black-tailed deer, and black bear.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, shore birds, muskrat, mink, and beaver.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large

stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials. affect plant growth. Flooding, wetness, slope, stoniness, and the amount' of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 10 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill-trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and

cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, and terraces and diversions.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (2) and the system adopted by the American Association of State Highway and Transportation Officials (1).

The Unified system classifies soils according to properties that affect their use as construction material (14). Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and, according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are. estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

physical and chemical properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low,* a change of less than 3 percent; *moderate,* 3 to 6 percent; and *high,* more than 6 percent. *Very high,* greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Tables 15 and 16 give estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes is not considered flooding.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 15 are the depth to the seasonal high water table; the kind of water table-that is perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 15.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavations.

Cemented pans are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

Some soils in this survey area are underlain by dense, compact glacial till. These soils are identified in the detailed map unit descriptions, general map unit descriptions, and series descriptions as having dense layers of glacial till. In the interpretation tables, however, they are identified as having a cemented pan. For most soil interpretations, the dense glacial till is the same as a cemented pan.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 16 shows the expected initial subsidence, which usually is a result of drainage, and annual subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (19). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 17, the soils of the survey area are classified according to the system (10). The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent *(Aqu,* meaning water, plus *ent,* from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Fluvaquents *(Fluv,* meaning flood plain, plus *aquent,* the suborder of the Entisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Aeric* identifies the subgroup that typifies the great group. An example is Aeric Fluvaquents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-silty, mixed, nonacid, mesic Aeric Fluvaquents.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (17). Many technical terms used in the descriptions are defined in Soil Taxonomy (19). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Alderwood series

The Alderwood series consists of moderately deep, moderately well drained soils on till plains. These soils formed in glacial till. Slope is 2 to 70 percent. Elevation is 50 to 550 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

Typical pedon of Alderwood gravelly sandy loam, 2 to 8 percent slopes, 200 feet south and 400 feet east of the center of sec. 28, T. 27 N., R. 5 E.

Ap-0 to 7 inches; very dark grayish brown (10YR 3/2) gravelly sandy loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; few fine interstitial pores; 20 percent pebbles; slightly acid; abrupt smooth boundary.

B21-7 to 21 inches; dark yellowish brown (10YR 4/4) very gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many fine roots; many fine tubular and interstitial pores; 40 percent pebbles; slightly acid; diffuse smooth boundary.

B22-21 to 30 inches; dark brown (10YR 4/3) very gravelly sandy loam; pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common fine roots; few very fine tubular pores; 40 percent pebbles; slightly acid; clear wavy boundary.

B3-30 to 35 inches; 50 percent olive brown (2.5Y 4/4) very gravelly sandy loam, light yellowish brown (2.5Y 6/4) dry, and 50 percent dark grayish brown (2.5Y 4/2) fragments of consolidated lodgment till with strong brown (7.5YR 5/6) coatings on fragments, tight brownish gray (2.5Y 6/2) and reddish yellow (7.5YR 6/6) dry; massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots; common fine tubular and interstitial pores; 45 percent pebbles; medium acid; abrupt wavy boundary.

IIC1sim-35 to 43 inches; dark grayish brown (2.5Y 4/2) duripan, light brownish gray (2.5Y 6/2) dry; dark yellowish brown (10YR 4/4), reddish brown (5YR 4/4), yellowish red (5YR 4/8), and strong brown (7.5YR 5/6) coatings on till fragments; massive; weakly cemented; extremely hard, extremely firm; few fine roots; few fine tubular pores; 40 percent pebbles; medium acid; abrupt irregular boundary.

IIC2-43 to 60 inches; grayish brown (2.5Y 5/2) compact glacial till that breaks to gravelly sandy loam, light gray (2.5Y 7/2) dry; massive; extremely hard, extremely firm, nonsticky and nonplastic, 20 percent pebbles; medium acid.

The duripan is at a depth of 20 to 40 inches. The mean annual soil temperature at a depth of 20 inches ranges from 48 to 52 degrees F. The control section averages 35 to 50 percent rock fragments. It is medium acid or slightly acid.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 to 4 when moist or dry.

The B horizon has hue of 10YR, 7.5YR, or 2.5YR, and it has value and chroma of 3 to 6 when moist or dry. It is very gravelly loam or very gravelly sandy loam.

The IIC1sim horizon has hue of 10YR or 2.5Y, value of 5 to 7 when dry, and chroma of 2 to 4 when dry. It is very gravelly sandy loam, very gravelly loamy sand, gravelly sandy loam, or gravelly loamy sand.

Bellingham series

The Bellingham series consists of very deep, poorly drained soils in depressional areas. These soils formed in alluvium and lake sediment. Slope is 0 to 3 percent. Elevation is 50 to 800 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 180 days.

Typical pedon of Bellingham silty clay loam about 1,150 feet south and 80 feet west of the northeast corner of sec. 27, T. 30 N., R. 5 E.

Ap-0 to 9 inches; very dark gray (10YR 3/1) silty clay loam, grayish brown (10YR 5/2) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; medium acid; clear smooth boundary.

B21g-9 to 21 inches; gray (5Y 5/1, 6/1) silty clay, light gray (2.5Y 7/0) dry; few fine and medium distinct strong brown (7.5YR 5/6) mottles and few fine distinct yellowish brown (10YR 5/6) mottles; few large distinct dusky red (2.5YR 3/2) organic stains; weak medium prismatic structure parting to moderate medium subangular blocky; very hard, very firm, sticky and very plastic; few fine roots; few fine and medium vertical pores; continuous pressure faces on peds; slightly acid; gradual smooth boundary.

B22g-21 to 60 inches; olive (5Y 5/6) and gray (5Y 6/1) silty clay, light gray (5Y 7/1) dry; few fine and medium distinct strong brown (7.5YR 5/6) mottles and common fine and medium distinct yellowish brown (10YR 5/6) mottles; few large distinct dusky red (2.5YR 3/2) organic stains; moderate medium subangular blocky structure; very hard, very firm, sticky and very plastic; very few fine roots; few very fine vertical pores; continuous pressure faces on peds; neutral.

The estimated mean annual soil temperature at a depth of 20 inches is 48 to 52 degrees F. The control section averages 40 to 60 percent clay.

The A horizon has value of 2 to 5 when moist or dry and chroma of 1 to 3.

The B horizon has hue of 5Y, 5GY, or 2.5Y, value of 5 to 7 when moist and 6 or 7 when dry, and chroma of 1 to 6.

Bellingham Variant

The Bellingham Variant consists of very deep, poorly drained soils in drainageways. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 650 to 1,800 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 130 to 150 days.

Typical pedon of Bellingham Variant mucky silty clay loam about 2,250 feet west and 1,400 feet south of the northeast corner of sec. 27, T. 30 N., R. 7 E.

O1-2 inches to 0; dead grass, leaves, and roots.

A1-0 to 6 inches; very dark grayish brown (10YR 3/2) mucky silty clay loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; strongly acid; clear smooth boundary.

AC-6 to 12 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; few medium distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; strongly acid; clear smooth boundary.

C1g-12 to 24 inches; gray (5Y 5/1) silty clay loam, light gray (2.5Y 7/0) dry; common medium distinct yellowish brown (10YR 5/8) mottles; massive; very hard, firm, sticky and plastic; few very fine and fine roots; very strongly acid; clear smooth boundary.

C2g-24 to 36 inches; gray (5Y 6/1) silty clay loam, light gray (5Y 7/1) dry; common medium distinct yellowish brown (10YR 5/8) mottles; massive; very hard, firm, sticky and plastic; few very fine roots; very strongly acid; clear smooth boundary.

C3g-36 to 42 inches; greenish gray (5GY 6/1) silty clay, greenish gray (5GY 5/1) dry; massive; very hard, firm, sticky and plastic; few very fine roots; very strongly acid; abrupt smooth boundary.

C4g-42 to 60 inches; greenish gray (5GY 6/1) stratified loamy fine sand and silty clay loam, greenish gray (5GY 5/1) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; very strongly acid.

The mean annual soil temperature at a depth of 20 inches ranges from 44 to 47 degrees F. The control section averages 35 to 45 percent clay.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 1 or 2 when moist or dry. The AC horizon has hue of 7.5YR to 2.5Y, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry.

The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 0 to 2 when moist or dry. The Cg horizon has hue of 5GY or 5Y, value of 5 or 6, and chroma of 1 or 2.

Cathcart series

The Cathcart series consists of very deep, well drained soils on foothills and mountain foot slopes. These soils formed in glacial drift derived from sandstone and siltstone and in volcanic ash. Slope is 3 to 50 percent. Elevation is 50 to 1,000 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 165 to 185 days.

Typical pedon of Cathcart loam, 3 to 15 percent slopes, 1,000 feet west and 1,500 feet south of the northeast corner of sec. 12, T. 32 N., R. 4 E.

Ap-0 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; common fine tubular pores; 5 percent granitic pebbles 2 millimeters to 3/4 inch in diameter; strongly acid; abrupt smooth boundary.

B21-8 to 17 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; few fine distinct yellowish red (5YR 4/6) mottles, strong brown (7.5YR 5/6) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; common fine tubular and interstitial pores; 10 percent granitic pebbles 2 millimeters to 3/4 inch in diameter, and 5 percent angular soft sandstone fragments 1 inch to 3 inches in diameter; 5 percent iron concretions 2 to 4 millimeters in diameter; strongly acid; clear smooth boundary.

B22-17 to 25 inches; yellowish brown (10YR 5/4) loam, very pale brown (10YR 7/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; few fine tubular pores and common fine interstitial pores; 10 percent granitic pebbles 2 millimeters to 3/4 inch in diameter; 5 percent iron concretions 2 to 4 millimeters in diameter; strongly acid; abrupt smooth boundary.

B3-25 to 35 inches; dark brown (10YR 4/3) sandy loam, very pale brown (10YR 7/4) dry; many fine prominent dark reddish brown (2.5YR 3/4) mottles, strong brown (7.5YR 5/6) dry; massive; hard, firm, slightly sticky and slightly plastic; weakly smeary; common fine interstitial pores; 35 percent soft angular sandstone fragments 3/4 inch to 3 inches in diameter; slightly acid; abrupt wavy boundary.

C1-35 to 53 inches; olive (5Y 5/3) loam, light gray (5Y 7/2) dry; many medium distinct dark reddish brown (2.5YR 3/4) mottles, reddish brown (5YR 4/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine interstitial pores; 20 percent soft angular sandstone fragments 3/4 inch to 3 inches in diameter; slightly acid; clear wavy boundary.

C2-53 to 60 inches; olive (5Y 5/3) loam, light gray (5Y 7/2) dry; many medium prominent dark reddish brown (2.5YR 3/4) mottles, reddish brown (5YR 4/4) dry; massive; hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and medium interstitial pores; 70 percent soft angular sandstone fragments 3/4 inch to 3 inches in diameter; slightly acid.

The mean annual soil temperature ranges from 40 to 52 degrees F. The profile ranges from very strongly acid to slightly acid. The control section averages 0 to 10 percent rock fragments.

The A horizon has hue of 10YR to 7.5YR and value of 2 to 4 when moist and 3 to 6 when dry. The B horizon has hue of 10YR to 2.5YR, value of 3 to 5 when moist and 3 to 7 when dry, and chroma of 2 to 4 when moist or dry. It is sandy loam, loam, or silt loam. The C horizon has hue of 10YR to 5Y, value of 3 to 5 when moist and 3 to 7 when dry, and chroma of 2 to 5 when moist or dry. It is loam or clay loam.

Custer series

The Custer series consists of very deep, poorly drained soils in basins on outwash plains. These soils formed in glacial outwash. Slope is 0 to 2 percent. Elevation ranges from near sea level to 150 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

Typical pedon of Custer fine sandy loam, 2,250 feet west and 1,500 feet north of the southeast corner of sec. 5, T. 30 N., R. 5 E. (fig. 4).

Ap-0 to 9 inches; very dark grayish brown (10YR 3/2) fine sandy loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many fine and medium roots; common fine tubular pores; medium acid; abrupt smooth boundary.

B21ircm-9 to 16 inches; 60 percent dark reddish brown (5YR 3/4 and 3/3) and dark brown (10YR 3/3) ortstein concretions 1 /2 inch to 2 inches in diameter, yellowish red (5YR 5/8 and 5/6) dry; 40 percent loamy fine sand that is olive (5Y 5/3) and light yellowish brown (10YR 6/4) when dry; massive; friable to slightly hard in matrix and very hard to extremely hard ortstein forming a discontinuous iron-cemented hardpan; nonsticky and nonplastic; few fine roots; few fine tubular pores; strongly acid; clear irregular boundary.

B22ir-16 to 35 inches; gray (5Y 5/1) and olive (5Y 5/3) medium sand, light brownish gray (2.5Y 6/2) dry; about 20 percent dark reddish brown (5YR 3/4) and dark brown (7.5YR 3/4) ortstein concretions 1 /8 inch to 2 inches in diameter; common fine and medium distinct dark reddish brown (5YR 3/4) and dark brown (7.5YR 3/4) mottles, light olive brown (2.5Y 5/6 and 5/4) dry; soft to slightly hard matrix and very hard to extremely hard ortstein forming a discontinuous iron-cemented hardpan; nonsticky and nonplastic; very few fine roots; common very fine tubular pores; strongly acid; clear wavy boundary.

C1g-35 to 49 inches; gray (N 5/0) fine and medium sand, olive gray and light olive gray (5Y 5/2 and 6/2) dry; common fine faint grayish brown (2.5Y 5/2) mottles; single grain; loose; many very fine interstitial pores; medium acid; abrupt wavy boundary.

IIC2g-49 to 60 inches; mottled dark gray (5Y 4/1) and dark brown (7.5YR 4/4) gravelly coarse sand, gray (5Y 6/1), light olive gray (5Y 6/2) and light olive brown (2.5Y 5/4) dry; single grain; loose; many very fine interstitial pores; 25 percent pebbles 2 millimeters to 3/4 inch in diameter; medium acid.

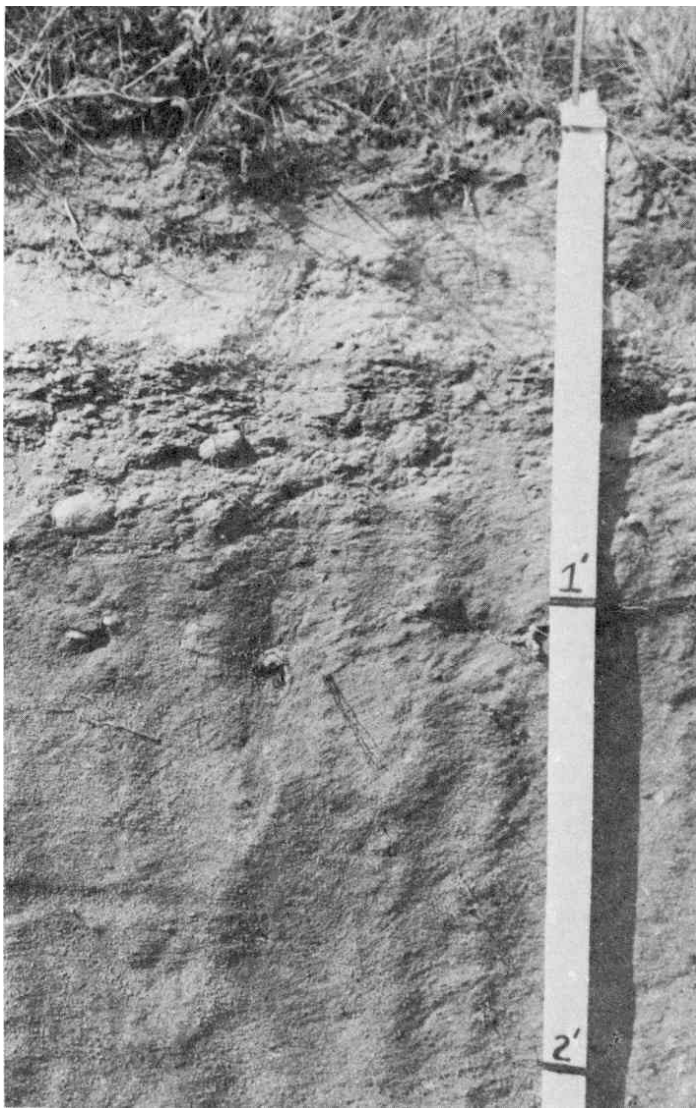

Figure 4.-Typical profile of Custer fine sandy loam.

The estimated mean annual soil temperature is 48 to 52 degrees F. The control section averages 0 to 15 percent rock fragments.

The A horizon has value of 2 or 3 when moist and 3 to 6

moist. Some pedons have an A2 horizon of loamy sand or fine sandy loam 1/2 inch to 2 inches thick.

The B2 horizon has hue of 5Y, 2.5Y, or 10YR in the matrix and 10YR to 5YR in the ortstein concretions and mottles. It has value of 3 to 5 when moist and 4 to 6 when dry, and it has chroma of 3 to 8 when dry and 3 to 6 when moist. The B2 horizon is loamy fine sand to sand. The ortstein occurs as rounded concretions, irregularly shaped accretions, nearly continuous bands, or slaglike, irregularly shaped plates that form a discontinuous, iron-cemented hardpan.

The C horizon has hue of 2.5Y, 5Y, or 10YR, value of 4 to 5 when moist and 5 to 7 when dry, and chroma of 0 to 4 when moist or dry. It is coarse sand to fine sand and is gravelly in some pedons.

Elwell series

The Elwell series consists of moderately deep, moderately well drained soils on mountainsides and ridgetops. These soils formed in glacial till and volcanic ash. Slope is 3 to 90 percent. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 45 degrees F, and the average frost-free season is 130 to 150 days.

Typical pedon of Elwell silt loam, 3 to 30 percent slopes, about 7 miles northeast of Granite Falls; 2,640 feet north and 1,570 feet west of the southeast corner of sec. 27, T. 31 N., R. 7 E.

O1-2 inches to 1 inch; leaves, needles, and twigs.

O2-1 inch to 0; decomposed mat of leaves, needles, and twigs.

A1-0 to 2 inches; black (10YR 2/1) silt loam, very dark brown (10YR 2/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; many fine tubular pores; extremely acid; abrupt smooth boundary.

B21ir-2 to 8 inches; strong brown (7.5YR 5/6) silt loam, reddish yellow (7.5YR 6/6) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; few fine tubular pores; 5 percent pebbles and 5 percent iron concretions; strongly acid; gradual wavy boundary.

B22ir-8 to 14 inches; brown (7.5YR 5/4) silt loam, light brown (7.5YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common medium and coarse roots; few fine tubular pores; 5 percent pebbles and 5 percent concretions; strongly acid; gradual wavy boundary.

B23-14 to 23 inches; yellowish brown (10YR 5/6) silt loam, yellow (10YR 7/6) dry; few fine faint brownish yellow (10YR 6/6) mottles, yellow (10YR 8/6) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine, medium, and coarse roots; few fine tubular pores; 10 percent pebbles; strongly acid; abrupt smooth boundary.

C1-23 to 27 inches; pale olive (5Y 6/4) gravelly fine sandy loam, pale yellow (5Y 7/4) dry; many large distinct dark yellowish brown (10YR 4/4) mottles, light yellowish brown (10YR 6/4) dry; weak medium platy structure; hard, firm, slightly sticky and slightly plastic; weakly smeary; few fine tubular pores; 20 percent pebbles; strongly acid; abrupt smooth boundary.

IIC2sim-27 inches; weakly cemented duripan that breaks down to olive (5Y 5/3) gravelly sandy loam, pale olive (5Y 6/3) dry; massive; hard, very firm, nonsticky and nonplastic; 20 percent pebbles; medium acid.

The mean annual soil temperature at a depth of 20 inches is 45 to 47 degrees F. Depth to the duripan ranges from 20 to 40 inches. The control section is 5 to 30 percent coarse fragments.

The A1 horizon has hue of 10YR or 7.5YR, and it has value of 2 or 3 when moist and 2 to 4 when dry. Some pedons have an A2 horizon that has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 6 when dry, and chroma of 1 to 3 when moist or dry.

The B21 it horizon has hue of 10YR, 7.5YR, or 5YR, value of 3 to 6 when moist and 4 to 7 when dry, and chroma of 2 to 6 when moist or dry. It is loam or silt loam. The B23 horizon has hue of 2.5Y, 5Y, or 10YR, value of 3 to 6 when moist and 5 to 8 when dry, and chroma of 4 to 6 when moist or dry.

The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 5 to 8 when dry, and chroma of 2 to 4 when moist or dry. It is gravelly loamy sand, gravelly fine sandy loam, gravelly sandy loam, or gravelly loam.

Everett series

The Everett series consists of very deep, somewhat excessively drained soils on terraces and outwash plains. These soils formed in glacial outwash. Slope is 0 to 70 percent. Elevation ranges from near sea level to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

Typical pedon of Everett gravelly sandy loam, 0 to 8 percent slopes, 2,550 feet east and 600 feet north from the southwest corner of sec. 14, T. 28 N., R. 6 E.

A1-0 to 1 inch; very dark grayish brown (10YR 3/2) gravelly loam, pale brown (10YR 6/3) dry; moderate fine granular structure; slightly hard, very friable, nonsticky and slightly plastic; many fine and medium roots; many fine interstitial pores; 20 percent pebbles; medium acid; abrupt smooth boundary.

B2ir-1 inch to 18 inches; dark brown (7.5YR 3/2) very gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak fine granular structure; slightly hard, very friable, nonsticky and slightly plastic; many fine and medium roots and few coarse roots; many fine interstitial pores and few fine tubular pores; 35 percent pebbles; slightly acid; abrupt smooth boundary.

C1-18 to 33 inches; dark brown (7.5YR 4/2) very gravelly loamy sand, reddish yellow (7.5YR 6/6) dry; common medium and large faint dark brown (7.5YR 4/4) mottles; massive; soft, very friable, nonsticky and nonplastic; many fine and medium pores and common fine interstitial pores; 40 percent pebbles; slightly acid; clear smooth boundary.

C2-33 to 60 inches; dark brown (7.5YR 4/4) and pale yellow (2.5Y 7/4) extremely gravelly sand, light brownish gray (2.5Y 6/2), brown (7.5YR 5/2), and light brown (7.5YR 6/4) dry; single grain; loose; very few fine roots; many fine interstitial pores; 65 percent pebbles; slightly acid.

The estimated mean annual soil temperature at a depth of 20 inches is 50 to. 54 degrees F. The solum is 15 to 35 inches thick. The control section averages 35 to 70 percent coarse fragments.

The A horizon has hue of 10YR to 7.5YR, value of 2 to 4 when moist and 4 to 6 when dry, and chroma of 1 to 3. The B horizon has hue of 10YR or 7.5YR, and it has value of 2 to 4 when moist and 4 to 6 when dry. The C horizon has hue of 7.5YR to 2.5Y, value of 2 to 4 when moist and 5 to 7 when dry, and chroma of 1 to 6. It ranges from extremely gravelly coarse sand to very gravelly loamy sand.

Getchell series

The Getchell series consists of moderately deep, moderately well drained soils on mountainsides and ridgetops. These soils formed in glacial till and volcanic ash. Slope is 3 to 90 percent. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 105 to 125 days.

Typical pedon of Getchell silt loam, 3 to 30 percent slopes, about 7 miles northeast of Granite Falls, 1,250 feet west and 250 feet north of the southeast corner of sec. 15, T. 31 N., R. 7 E.

O1-1 1/2 inches to 1 inch; leaves, needles, and twigs.

O2-1 inch to 0; decomposed mat of needles, twigs, and leaves.

A1-0 to 2 inches; black (10YR 2/1) and very dark brown (10YR 2/2) silt loam, very dark brown (10YR 2/2) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine, medium, and coarse roots; many fine interstitial pores; 10 percent rounded pebbles; extremely acid; abrupt smooth boundary.

B21hir-2 to 4 inches; yellowish red (5YR 4/6) silt loam, strong brown (7.5YR 5/6) dry; dark reddish brown (5YR 3/2) coatings on peds, dark reddish brown (5YR 3/4) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; few fine tubular pores; 10 percent pebbles and 5 percent iron concretions; strongly acid; abrupt wavy boundary.

B22hir-4 to 10 inches; strong brown (7.5YR 5/6) silt loam, yellowish brown (10YR 5/8) dry; reddish brown (5YR 4/4) coatings on peds, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common medium and coarse roots; few fine tubular pores; 10 percent pebbles and 2 percent cobbles; strongly acid; gradual wavy boundary.

B31-10 to 20 inches; strong brown (7.5YR 5/8) silt loam, light yellowish brown (10YR 6/4) dry; dark brown (7.5YR 4/4) coatings in cracks, dark yellowish brown (10YR 4/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few medium roots; few fine tubular pores; 10 percent pebbles and 2 percent cobbles; strongly acid; clear wavy boundary.

B32-20 to 29 inches; light olive brown (2.5Y 5/4) silt loam, very pale brown (10YR 7/3 and 7/4) dry; many fine and medium distinct dark reddish brown (5YR 3/3), strong brown (7.5YR 5/8), and dark brown (7.5YR 4/4) coatings in old root channels, strong brown (7.5YR 5/6) and dark brown (7.5YR 4/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few medium roots; common fine tubular pores; 10 percent pebbles and 2 percent cobbles; strongly acid; clear smooth boundary.

B33-29 to 36 inches; dark brown (7.5YR 3/2 and 3/4) silt loam, yellowish brown (10YR 5/6) dry; common fine faint strong brown (7.5YR 5/6) mottles, dark yellowish brown (10YR 4/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few medium roots; few fine tubular pores; 10 percent pebbles and 2 percent cobbles; strongly acid; abrupt smooth boundary.

IICr-36 to 75 inches; olive (5Y 5/3) and pale olive (5Y 6/3) dense glacial till that breaks to sandy loam, light gray (5Y 7/2) and light olive gray (5Y 6/2) dry; extremely hard, very firm; few fine tubular pores; 10 percent pebbles and 2 percent cobbles inbedded in pan; few fine tubular pores; strongly acid.

The mean annual soil temperature at a depth of 20 inches is 43 to 45 degrees F. Depth to the IICr horizon ranges from 20 to 40 inches. The control section averages 5 to 15 percent coarse fragments.

The A1 horizon has value of 2 or 3 when dry.

The B2ir horizon has hue of 10YR to 5YR, value of 3 to 6 when moist and 4 to 7 when dry, and chroma of 2 to 8 when moist or dry. It is loam or silt loam. The B3 horizon has hue of 2.5Y, 5Y, 7.5YR, or 10YR, value of 3 to 6 when moist and 5 to 7 when dry, and chroma of 2 to 8 when moist or dry.

The IICr horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 5 to 8 when dry, and chroma of 2 to 4 when moist or dry. It is dense glacial till that breaks to sandy loam or loam.

Greenwater series

The Greenwater series consists of very deep, somewhat excessively drained soils on terraces. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 400 to 600 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Greenwater loamy sand, 1,300 feet west and 1,200 feet north of the southeast corner of sec. 11, T. 32 N., R. 9 E.

O1-1 inch to 0; matted roots, leaves, needles, and twigs.

A2-0 to 2 inches; dark brown (7.5YR 3/2) loamy sand, gray (7.5YR 5/0) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine, fine, medium, and coarse roots; medium acid; clear smooth boundary.

B21ir-2 to 9 inches;. dark brown (10YR 4/3) loamy sand, grayish brown (10YR 5/2) dry; dark brown (7.5YR 4/4) stains over 40 percent of sand grains; massive; soft, very friable, nonsticky and nonplastic; common very fine, fine, medium and coarse roots; 1 to 4 percent fine pumice; medium acid; abrupt smooth boundary.

B22ir-9 to 21 inches; dark brown (10YR 4/3) loamy sand, brown (10YR 5/3) dry; dark reddish brown (5YR 3/4) stains over 40 percent of sand grains; massive; soft, very friable, nonsticky and nonplastic; common very fine, fine, medium, and coarse roots; 5 to 10 percent fine pumice; medium acid; abrupt smooth boundary.

C1-21 to 40 inches; dark gray (2.5Y 4/1) sand, gray (2.5Y 5/1) dry; many large distinct weak red (2.5YR 4/2) mottles; single grain; loose; common very fine roots and few fine, medium, and coarse roots; 1 to 4 percent pumice; less than 5 percent pebbles; slightly acid; clear wavy boundary.

C2-40 to 60 inches; dark gray (2.5Y 4/1) sand, gray (2.5Y 5/1) dry; single grain; loose; 1 to 4 percent fine pumice; less than 5 percent pebbles; slightly acid.

The mean annual soil temperature is 48 to 51 degrees F. The profile usually is moist, but it is dry throughout for more than 60 consecutive days each year. The profile is medium acid to slightly acid. The control section is less than 15 percent coarse fragments. The profile averages 5 to 25 volcanic ash, cinders, and pumice.

The A horizon has value of 2 or 3 when moist, and it has chroma of 2 or 3 when moist.

The Bir horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 2 to 4 when moist or dry. It is loamy sand or sand.

The C horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 to 4. Sand stratified with thin layers of sandy loam and silt loam is at a depth of more than 40 inches.

Hartnit series

The Hartnit series consists of moderately deep, moderately well drained soils on mountainsides and ridgetops. These soils formed in glacial till, volcanic ash, and material weathered from andesite, argillite, and basalt. Slope is 3 to 90 percent. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free season is 90 to 100 days.

Typical pedon of Hartnit gravelly silt loam, 65 to 90 percent slopes, 1,100 feet west and 1,800 feet north of the southeast corner of sec. 17, T. 28 N., R. 9 E.

O1-7 to 6 inches; leaves, needles, and twigs.

O2-6 inches to 0; decomposed mat of needles, twigs, and leaves.

A1-0 to 4 inches; black (5YR 2/1) gravelly silt loam, very dark gray (5YR 3/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; many fine interstitial pores; 20 percent pebbles; strongly acid; abrupt wavy boundary.

A2-4 to 7 inches; gray (10YR 5/1) gravelly silt loam, light gray (10YR 7/1) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; many fine interstitial pores; 30 percent rounded pebbles; strongly acid; abrupt wavy boundary.

B21hir-7 to 11 inches; dark reddish brown (5YR 3/4) gravelly silt loam, reddish brown (5YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; common tubular pores; 30 percent rounded pebbles; strongly acid; clear wavy boundary.

B22-11 to 20 inches; strong brown (7.5YR 5/6) gravelly silt loam, reddish yellow (7.5YR 6/6) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; few tubular

pores; 30 percent angular and rounded pebbles; medium acid; clear smooth boundary.

B23-20 to 27 inches; dark brown (10YR 4/3) gravelly silt loam; pale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; 30 percent angular andesite pebbles; medium acid; abrupt wavy boundary.

R-27 inches; andesite.

The mean annual soil temperature at a depth of 20 inches is 41 to 43 degrees F. Bedrock is at a depth of 20 to 40 inches.

The A1 horizon has hue of 7.5YR or 5YR and chroma of 1 to 3 when moist or dry. The A2 horizon has hue of 7.5YR or 10YR, value of 5 or 6 when moist and 6 or 7 when dry, and chroma of 1 to 3 when moist or dry. It is gravelly silt loam, gravelly loam, or cobbly loam.

The B horizon has value of 4 to 6 when dry and chroma of 3 to 6 when moist or dry. It is gravelly silt loam, gravelly loam, or cobbly loam.

Indianola series

The Indianola series consists of very deep, somewhat excessively drained soils on terraces and outwash plains. These soils formed in sandy glacial outwash. Slope is 15 to 25 percent. Elevation is 50 to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typical pedon of Indianola loamy sand, 15 to 25 percent slopes, 1,650 feet north and 1,000 feet east of the southwest corner of sec. 31, T. 27 N., R. 5 E.

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

A1-0 to 4 inches; very dark grayish brown (10YR 3/2) loamy sand, brown (10YR 5/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many fine, medium, and coarse roots; common fine tubular pores; slightly acid; clear wavy boundary.

B21ir-4 to 8 inches; dark yellowish brown (10YR 4/4) loamy sand, light yellowish brown (10YR 6/4) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many fine and medium roots; few fine tubular pores; slightly acid; clear wavy boundary.

B22ir-8 to 13 inches; dark yellowish brown (10YR 4/4) loamy sand, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; common fine and medium roots; few fine tubular pores; slightly acid; gradual wavy boundary.

B23ir-13 to 24 inches; dark yellowish brown (10YR 4/4) loamy sand, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; few roots; slightly acid; abrupt smooth boundary.

C1-24 to 47 inches; light olive gray (5Y 6/2) sand, light gray (5Y 7/2) dry; single grain; loose; few roots; few very fine tubular pores; slightly acid; gradual smooth boundary.

C2-47 to 60 inches; grayish brown (2.5Y 5/2) sand, light gray (2.5Y 7/2) dry; single grain; loose; few roots; few very fine tubular pores; slightly acid.

The estimated mean annual soil temperature is 47 to 52 degrees F. The profile is neutral to strongly acid. The control section is less than 15 percent coarse fragments.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 to 6 when dry, and chroma of 1 to 3 when moist or dry.

The B horizon has hue of 10YR or 7.5YR, and it has value of 3 or 4 when moist and .4 to 6 when dry. It is loamy fine sand or loamy sand.

The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry. It is loamy fine sand to sand.

Kitsap series

The Kitsap series consists of very deep, moderately well drained soils on terraces and terrace escarpments. These soils formed in lacustrine sediment. Slope is 0 to 50 percent. Elevation ranges from near sea level to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 200 days.

Typical pedon of Kitsap silt loam, 0 to 8 percent slopes, 1,400 feet north and 1,250 feet west of the southeast corner of sec. 32, T. 27 N., R. 5 E.

Ap-0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots and common medium roots; common fine pores; medium acid; abrupt smooth boundary.

B21-6 to 12 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry, moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; common fine pores; slightly acid; clear wavy boundary.

B22-12 to 20 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; many medium distinct dark brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; few fine pores; slightly acid; clear *wavy* boundary.

B3-20 to 33 inches; olive brown (2.5Y 4/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; many large prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine pores; slightly acid; clear smooth boundary.

C-33 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam, pale yellow (2.5Y 7/4) dry; few fine distinct

yellowish brown (10YR 5/6) mottles; massive; hard, firm, sticky and plastic; few fine pores; finely stratified with silt loam; slightly acid.

The estimated mean annual soil temperature at a depth of 20 inches is 50 to 53 degrees F. The control section averages less than 15 percent coarse fragments.

The A horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The B2 horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 3 or 4 when moist or dry. It is silt loam or silty clay loam. The B3 horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 3 or 4 when moist or dry. It is silt loam or silty clay loam.

The C horizon has hue of 10YR, 5Y, or 2.5Y, value of 5 or 6 when moist and 7 or 8 when dry, and chroma of 3 or 4 when moist or dry. It is stratified silt loam or silty clay loam. Some pedons contain strata of fine sand or silty clay.

Lynnwood series

The Lynnwood series consists of very deep, somewhat excessively drained soils on terraces, terrace escarpments, and outwash plains. These soils formed in glacial outwash. Slope is 0 to 90 percent. Elevation is 50 to 500 feet. The average annual precipitation is about 40, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typical pedon of Lynnwood loamy sand, 0 to 3 percent slopes, about 5 miles north of Arlington, 2,600 feet west and 980 feet north of the southeast corner of sec. 22, T. 32 N., R. 5 E.

O1-3 to 2 inches; leaves, needles, and twigs.

O2-2 inches to 0; decomposed mat of needles, twigs, and leaves.

A2-0 to 1 inch; grayish brown (10YR 5/2) loamy sand, light gray (10YR 7/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; many very fine pores; strongly acid; clear smooth boundary.

B21ir-1 inch to 7 inches; dark brown (7.5YR 4/4) loamy sand, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; many very fine pores; many semiround concretions 1 /2 to 1 millimeters in size; strongly acid; clear smooth boundary.

B22ir-7 to 15 inches; dark brown (7.5YR 4/4) loamy sand, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; many very fine interstitial pores; strongly acid; clear smooth boundary.

B3-15 to 29 inches; dark yellowish brown (10YR 4/4) loamy sand, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; common fine and medium roots; slightly acid; abrupt smooth boundary.

C-29 to 60 inches; grayish brown (2.5Y 5/2) sand, light gray (2.5Y 7/2) dry; single grain; loose; few fine and medium roots; medium acid.

The estimated mean annual soil temperature is 47 to 50 degrees F. The control section averages 0 to 15 percent rock fragments.

The A2 horizon has value of 4 or 5 when moist and 6 to 8 when dry, and it has chroma of 1 to 3 when moist or dry.

The B2 horizon has hue of 7.5YR or 5YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 3 to 6 when moist or dry. It is loamy sand or loamy fine sand. The B3 horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 3 or 4 when moist or dry.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 when moist and 5 to 7 when dry, and it has chroma of 2 to 4 when moist or dry. It is loamy fine sand to sand.

McKenna series

The McKenna series consists of moderately deep, poorly drained soils in depressional areas and drainageways on till plains. These soils formed in glacial till. Slope is 0 to 8 percent. Elevation is 100 to 800 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 180 days.

Typical pedon of McKenna gravelly silt loam, 0 to 8 percent slopes, 1,530 feet west and 2,980 feet south of the northeast corner of sec. 23, T. 27 N., R. 5 E.

A1-0 to 8 inches; very dark grayish brown (10YR 3/2) gravelly silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, medium, and coarse roots; common fine tubular pores; 20 percent pebbles; medium acid; abrupt smooth boundary.

B21-8 to 16 inches; dark brown (10YR 4/3) gravelly silt loam, light brownish gray (10YR 6/2) dry; few fine faint yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common fine tubular pores; 25 percent pebbles; medium acid; clear smooth boundary.

B22-16 to 33 inches; light olive brown (2.5Y 5/4) gravelly silt loam, light gray (2.5Y 7/2) dry; few fine faint brownish yellow (10YR 6/6) mottles; moderate medium subangular blocky structure; slightly hard,

friable, slightly sticky and slightly plastic; few very fine and fine roots; 25 percent pebbles; medium acid; abrupt smooth boundary.

Cr-33 to 60 inches; olive (5Y 5/3) dense glacial drift that breaks to very gravelly sandy loam, light gray (5Y 7/2) dry; many medium distinct brown (10YR 5/3) mottles and few fine faint brownish yellow (10YR 6/6) mottles; compact; very hard, very firm, slightly sticky and slightly plastic; 40 percent pebbles; slightly acid.

Thickness of the solum and depth to the compact glacial till are 20 to 40 inches. The particle-size control section is 20 to 35 percent clay in the fine earth fraction.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 2 to 4 when dry, and chroma of 1 or 2 when moist or dry. The B2 horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry. It is gravelly silt loam, gravelly loam, or gravelly clay loam. The Cr horizon is 35 to 65 percent gravel.

The McKenna soils in this survey area are taxadjunct to the McKenna series because they have slightly less than 35 percent rock fragments in the control section. This difference, however, does not affect the use and management of the soils.

Menzel series

The Menzel series consists of very deep, well drained soils on terraces. These soils formed in alluvium and volcanic ash. Slope is 0 to 3 percent. Elevation is 200 to 500 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 140 to 200 days.

Typical pedon of Menzel silt loam, 0 to 3 percent slopes, 600 feet east and 450 feet north of the southwest corner of sec. 32, T. 30 N., R. 7 E.

O1-1/2 inch to 0; thick matted roots.

Ap-0 to 4 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine roots, common fine roots, and few medium and coarse roots; slightly acid; clear wavy boundary.

B2-4 to 9 inches; strong brown (7.5YR 5/6) silt loam, brownish yellow (10YR 6/6) dry; moderate coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine roots and common fine, medium, and coarse roots; slightly acid; clear wavy boundary.

B3-9 to 16 inches; dark yellowish brown (10YR 4/4) very fine sandy loam, pale yellow (2.5Y 7/4) dry; weak coarse subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; weakly smeary; many very fine roots and common fine, medium, and coarse roots; slightly acid; gradual wavy boundary.

C1-16 to 31 inches; light olive brown (2.5Y 5/4) fine sandy loam, pale yellow (5Y 7/3) dry; massive; slightly hard, firm, slightly sticky and slightly plastic; common very fine, fine, medium, and coarse roots; slightly acid; abrupt wavy boundary.

C2-31 to 60 inches; light olive brown (2.5Y 5/3) fine sandy loam, pale yellow (2.5Y 7/4) dry; massive; soft, friable, slightly sticky and nonplastic; thin discontinuous strata of loamy sand and loamy fine sand 1/2 to 1 inch thick; few very fine and fine roots; neutral.

The mean annual soil temperature at a depth of 20 inches is 48 to 52 degrees F. The control section is 0 to 10 percent rock fragments.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 or 2 when moist or dry.

The B2 horizon has hue of 10YR or 7.5YR, value of 4 to 7 when moist or dry, and chroma of 4 to 6 when moist or dry. It is silt loam, very fine sandy loam, or loam. The B3 horizon is silt loam, very fine sandy loam, or loam.

The C horizon has hue of 10YR, 5Y, or 2.5Y, and it has value of 4 to 6 when moist and 5 to 7 when dry. It is silt loam, very fine sandy loam, or fine sandy loam.

Mukilteo series

The Mukilteo series consists of very deep, very poorly drained organic soils in depressional areas. These soils formed in organic material derived dominantly from sedges. Slope is 0 to 1 percent. Elevation is 20 to 1,000 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

Typical pedon of Mukilteo muck, 1,200 feet east and 800 feet north of the southwest corner of sec. 25, T. 28 N., R. 6 E.

Oe1-0 to 4 inches; dark reddish brown (5YR 2/2, on broken faces) muck; about 40 percent fibers, 15 percent rubbed; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots; very strongly acid; abrupt wavy boundary.

Oe2-4 to 8 inches; dark reddish brown (5YR 2/2 and 3/2, on broken faces) rubbed and pressed hemic material; about 45 percent fibers, 20 percent rubbed; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; very strongly acid; clear smooth boundary.

Oe3-8 to 13 inches; dark reddish brown (5YR 2/2 and 3/2, on broken faces), rubbed and pressed hemic material; about 55 percent fibers, 25 percent rubbed;

moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; very strongly acid; clear smooth boundary.

Oe4-13 to 27 inches; black (5YR 2/1, on broken faces) rubbed and pressed hemic material; about 40 percent fibers, 18 percent rubbed; massive; hard, friable, nonsticky and nonplastic; very strongly acid; abrupt smooth boundary.

Oe5-27 to 35 inches; black (5YR 2/1, on broken faces) rubbed and pressed hemic material; about 78 percent fibers, 40 percent rubbed; massive; hard, friable, nonsticky and nonplastic; very strongly acid; abrupt smooth boundary.

Oa1-35 to 54 inches; black (5YR 2/1, on broken faces) rubbed and pressed sapric material; about 15 percent fibers, less than 5 percent rubbed; massive; hard, friable, nonsticky and nonplastic; very strongly acid; abrupt smooth boundary.

IIc-54 to 60 inches; olive gray (5Y 5/2) fine sandy loam, light gray (5Y 7/2) when dry; massive; soft, very friable, nonsticky and nonplastic; neutral.

The organic material is 52 inches to more than 60 inches thick. The estimated soil temperature at a depth of 20 inches is 46 to 52 degrees F. These soils are usually saturated with water. Fibers are mainly sedge.

The surface tier has hue of 5YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. It commonly has one or more layers of sapric material that has less than 15 percent fiber when rubbed. It has weak to moderate blocky structure. The subsurface tiers are hemic material that have hue of 5YR to 10YR and have value and chroma of 1 to 4. The rubbed fiber content ranges from 18 to 50 percent. The bottom tier is similar in color and fiber content to the subsurface tier, but it generally is higher in fiber content.

Nargar series

The Nargar series consists of very deep, well drained soils on high terraces and terrace escarpments. These soils formed in sandy alluvium and volcanic ash. Slope is 0 to 90 percent. Elevation is 400 to 1,200 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 120 to 180 days.

Typical pedon of Nargar fine sandy loam, 0 to 15 percent slopes, 1,000 feet west and 2,600 feet north of the southeast corner of sec. 2, T. 32 N., R. 7 E.

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

O2-1/2 inch to 0; black (10YR 2/1) decomposed litter.

A2-0 to 1 inch; gray (5YR 5/1) very fine sandy loam, light gray (5YR 7/1) dry; massive; hard, firm, slightly sticky and nonplastic; common very fine, fine, medium, and coarse roots; common very fine vesicular pores; slightly acid; abrupt irregular boundary.

B21ir-1 inch to 8 inches; yellowish red (5YR 5/8) fine sandy loam, strong brown (7.5YR 5/6) dry; yellowish red (5YR 4/6) stains on 20 percent of faces of peds; moderate coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine, fine, and medium roots and few coarse roots; common very fine vesicular pores; 10 percent shot 2 to 5 millimeters in size; slightly acid; clear wavy boundary.

B22-8 to 15 inches; dark brown (7.5YR 4/4) fine sandy loam, strong brown (7.5YR 5/6) dry; moderate medium subangular blocky structure; hard, very firm, slightly sticky and slightly plastic; weakly smeary; common very fine, fine, and medium roots and few coarse roots; few very fine vesicular pores; 5 percent shot 2 to 5 millimeters in size; medium acid; clear wavy boundary.

B23-15 to 26 inches; dark yellowish brown (10YR 4/4) fine sandy loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine, fine, and medium roots and few coarse roots; few very fine vesicular pores; slightly acid; clear wavy boundary.

IIC1-26 to 41 inches; olive gray (5Y 4/2) fine sand, olive (5Y 5/3) dry; single grain; loose; few very fine, fine, and medium roots; 30 percent weakly cemented fine sand nodules 2 to 3 millimeters in size; slightly acid; abrupt smooth boundary.

IIC2-41 to 47 inches; light olive brown (2.5Y 5/4) very gravelly loamy coarse sand, pale olive (5Y 6/3) dry; single grain; loose; few very fine and fine roots; 50 percent fine rounded pebbles; slightly acid; clear smooth boundary.

IIC3-47 to 60 inches; olive gray (5Y 5/2) very gravelly loamy coarse sand, light olive gray (5Y 6/2) dry; single grain; loose; 50 percent fine rounded pebbles; slightly acid.

The estimated mean annual soil temperature at a depth of 20 inches is 47 to 50 degrees F. The solum is 15 to 40 inches thick. It averages 0 to 15 percent rock fragments.

The A2 horizon has hue of 5YR, 7.5YR, or 10YR, and it has value of 4 or 5 when moist and 6 or 7 when dry. The B2 horizon is loam, fine sandy loam, or sandy loam. The IIC horizon has hue of 10YR, 5Y, or 2.5Y. It is stratified with loamy coarse sand to fine and coarse sand. Individual strata are 0 to 60 percent coarse fragments, but the horizon averages 15 to 50 percent.

Nargar Variant

The Nargar Variant consists of very deep, well drained soils on terrace escarpments and mountainsides. These soils formed in sandy alluvium and volcanic ash. Slope is 3 to 30 percent. Elevation is 800 to 1,800 feet. The

average annual precipitation is about 70 inches, the average annual air temperature is about 45 degrees F, and the average frost-free season is 110 to 140 days.

Typical pedon of Nargar Variant sandy loam, 3 to 30 percent slopes, 1,300 feet north and 1,350 feet east of the southwest corner of sec. 3, T. 31 N., R. 6 E.

O1-2 inches to 0; black (10YR 2/1) leaves, twigs, and needles.

A1-0 to 4 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many fine, medium, and coarse roots; many very fine pores; medium acid; abrupt wavy boundary.

B21ir-4 to 11 inches; reddish brown (5YR 5/4) sandy loam, light reddish brown (5YR 6/4) dry; moderate coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; common very fine pores; medium acid; clear wavy boundary.

B22-11 to 18 inches; dark brown (7.5YR 4/4) sandy loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; few very fine pores; medium acid; clear wavy boundary.

B23-18 to 31 inches; dark yellowish brown (10YR 4/4) sandy loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; few fine pores; slightly acid; clear wavy boundary.

IIC1-31 to 42 inches; yellowish brown (10YR 5/4) loamy coarse sand, light yellowish brown (10YR 6/4) dry; single grain; loose; few fine roots; many fine pores; slightly acid; abrupt smooth boundary.

IIC2-42 to 60 inches; light olive brown (2.5Y 5/4) very gravelly coarse sandy loam, light yellowish brown (2.5Y 6/4) dry; single grain; loose; very few fine roots; 50 percent fine round pebbles; slightly acid.

The solum is 15 to 40 inches thick and averages 0 to 15 percent coarse fragments.

The A1 horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 1 or 2 when moist or dry.

The B2 horizon is fine sandy loam or sandy loam.

The IIC horizon has hue of 10YR, 5Y, or 2.5Y, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist or dry. It is stratified coarse sandy loam to fine coarse sand. Individual strata are 0 to 60 percent coarse fragments, but the horizon averages 15 to 50 percent.

Norma series

The Norma series consists of very deep, poorly drained soils in depressional areas on outwash plains and till plains. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 20 to 600 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

Typical pedon of Norma loam, 2,350 feet north and 1,590 feet west of the southeast corner of sec. 29, T. 27 N., R. 5 E.

Ap-0 to 10 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine, medium, and coarse roots; many very fine tubular pores; slightly acid; abrupt wavy boundary.

B2g-10 to 28 inches; dark grayish brown (2.5Y 4/2) sandy loam, light brownish gray (2.5Y 6/2) dry; common medium prominent yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine roots; many very fine pores; slightly acid; clear wavy boundary.

Cg-28 to 60 inches; dark gray (5Y 4/1) sandy loam, gray (5Y 6/1) dry; common fine prominent red (2.5YR 4/6) and yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable, nonsticky and nonplastic; thin loamy sand to silty clay loam strata; few roots; many very fine pores; slightly acid.

The control section averages less than 20 percent coarse fragments, less than 18 percent clay, and more than 15 percent fine and coarse sand.

The B horizon is sandy loam, silt loam, or fine sandy loam. The C horizon is stratified loamy sand to silty clay loam.

Norma Variant

Norma Variant consists of very deep, poorly drained soils in depressional areas on outwash plains. These soils formed in glacial outwash. Slope is 0 to 3 percent. Elevation is 50 to 400 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typical pedon of Norma Variant loam, 2,650 feet west and 50 feet north of the southeast corner of sec. 29, T. 31 N., R. 5 E.

Ap-0 to 9 inches; dark reddish brown (5YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; very strongly acid; abrupt smooth boundary.

B21g-9 to 18 inches; light olive gray (5Y 6/2) sandy clay loam, light gray (5Y 7/2) dry; common medium distinct yellowish red (5YR 4/6) mottles, reddish yellow (5YR 6/6) dry; moderate medium subangular

blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many fine, medium, and coarse interstitial pores; medium acid; clear smooth boundary.

B22g-18 to 26 inches; grayish brown (2.5Y 5/2) sandy clay loam, light brownish gray (2.5Y 6/2) dry; many coarse prominent yellowish red (5YR 4/6) mottles, reddish yellow (5YR 6/6) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many fine, medium, and coarse pores; medium acid; abrupt smooth boundary.

C1g-26 to 35 inches; olive gray (5Y 5/2) sandy loam, light olive gray (5Y 6/2) dry; common fine distinct strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry; massive; slightly hard, friable, slightly sticky and nonplastic; few fine roots; many fine, medium, and coarse pores; slightly acid; clear smooth boundary.

C2g-35 to 60 inches; olive gray (5Y 5/2) loamy sand, light olive gray (5Y 6/2) dry; single grain; loose; few fine pores; slightly acid.

The upper part of the control section is 20 to 35 percent clay. The lower part is sandy loam or loamy sand.

The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 1 or 2 when moist or dry. The B2g horizon has hue of 2.5Y or 5Y, value of 4 to 7 when moist and 5 to 8 when dry, and chroma of 1 or 2 when moist or dry. It is sandy clay loam or clay loam. The C horizon is sandy loam, loamy sand, or loamy fine sand.

Ogarty series

The Ogarty series consists of moderately deep, moderately well drained soils on foothills and mountain sides. These soils formed in volcanic ash and material weathered from andesite. Slope is 2 to 60 percent. Elevation is 500 to 1,000 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 180 days.

Typical pedon of Ogarty very gravelly loam, 1,800 feet east and 2,100 feet north of the southwest corner of sec. 3, T. 28 N., R. 7 E.

O1-1 1/2 inches to 1/2 inch; forest litter.

O2-1/2 inch to 0; decomposed litter.

A1-0 to 1 inch; very dark gray (10YR 3/1) very gravelly loam, gray (10YR 5/1) dry; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, medium, and coarse roots; many very fine discontinuous pores; 15 percent cobbles and 40 percent fine pebbles; very strongly acid; abrupt wavy boundary.

B21-1 inch to 10 inches; dark brown (7.5YR 4/4) very gravelly loam, yellowish brown (10YR 5/4) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, medium, and coarse roots; many very fine discontinuous pores; 10 percent cobbles, 45 percent pebbles, and 10 percent shot 2 to 5 millimeters in size; medium acid; clear broken boundary.

B22-10 to 20 inches; dark brown (7.5YR 4/4) extremely gravelly loam, light yellowish brown (10YR 6/4) dry; moderate and weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine, fine, medium, and coarse roots; many very fine discontinuous pores; 10 percent cobbles, 60 percent fine angular pebbles, and 10 percent shot 2 to 5 millimeters in size; medium acid; gradual wavy boundary.

B3-20 to 32 inches; brown (7.5YR 5/4) extremely gravelly loam, light yellowish brown (10YR 6/4); weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine, fine, medium, and coarse roots; common very fine discontinuous pores; 75 percent fine angular pebbles and 5 percent shot 2 to 5 millimeters in size; medium acid; clear wavy boundary.

C1-32 to 35 inches; dark brown (7.5YR 4/4) extremely gravelly loam, yellowish brown (10YR 5/6) dry; massive; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots and few medium and coarse roots; few pores; 70 percent fine angular pebbles; medium acid; clear broken boundary.

C2-35 to 38 inches; yellowish red (5YR 4/6) extremely gravelly loam, yellowish brown (10YR 5/6) dry; massive; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine, fine, medium, and coarse roots; few pores; 90 percent angular pebbles; medium acid; abrupt smooth boundary.

R-38 inches; andesite.

The estimated mean annual soil temperature at a depth of 20 inches is 47 to 50 degrees F. Depth to bedrock ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 1, 2, or 3 when moist or dry. The B and C horizons have hue of 5YR to 10YR, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist or dry. They are very gravelly loam or extremely gravelly loam.

Olomount series

The Olomount series consists of moderately deep, moderately well drained soils on mountainsides and ridgetops. These soils formed in glacial till, volcanic ash,

and material weathered dominantly from andesite, argillite, and basalt. Slope is 3 to 90 percent. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 130 to 150 days.

Typical pedon of Olomount gravelly loam, 3 to 15 percent slopes, 1,400 feet east and 2,300 feet south of the northwest corner of sec. 33, T. 31 N., R. 7 E.

O1-2 1/2 to 2 inches; leaves, needles, and mosses.
O2-2 inches to 0; partially decomposed litter.
A1 -0 to 2 inches; very dark grayish brown (10YR 3/2) gravelly loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; many fine interstitial pores; 20 percent pebbles; strongly acid; clear smooth boundary.
B21ir-2 to 7 inches; reddish brown (5YR 5/4) gravelly loam, light reddish brown (5YR 6/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; few fine interstitial pores; 20 percent pebbles; medium acid; clear smooth boundary.
B22-7 to 18 inches; dark brown (7.5YR 4/4) gravelly loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and medium roots; few fine interstitial pores; 20 percent pebbles; medium acid; clear smooth boundary.
C1-18 to 27 inches; dark brown (7.5YR 4/4) very gravelly loam, brown (7.5YR 5/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and medium roots; 60 percent pebbles; slightly acid; clear smooth boundary.
C2-27 to 32 inches; dark brown (7.5YR 4/4) extremely gravelly loam, brown (7.5YR 5/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; 80 percent pebbles; slightly acid; abrupt smooth boundary.
IIR-32 inches; andesite.

The mean annual soil temperature at a depth of 20 inches ranges from 45 to 47 degrees F. Depth to bedrock ranges from 20 to 40 inches. The control section is 35 to 60 percent coarse fragments.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has value of 2 to 5 when moist. and 3 to 6 when dry, and it has chroma of 3 to 6 when moist or dry. It is gravelly loam, cobbly loam, or gravelly silt loam.

The C horizon has hue of 10YR or 7.5YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 to 6 when moist or dry. It is extremely gravelly loam, extremely gravelly silt loam, or very gravelly silt loam.

Orcas series

The Orcas series consists of very deep, very poorly drained soils in basins on hills. These soils formed in sphagnum moss. Slope is 0 to 2 percent. Elevation is 100 to 500 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 180 days.

Typical pedon of Orcas peat, 2,190 feet north and 2,125 feet east of the southwest corner of sec. 18, T. 30 N., R. 7 E.

Oi1-0 to 3 inches; dark reddish brown (5YR 2/2, broken face) fibric material, dark reddish brown (5YR 3/4) pressed and rubbed; about 90 percent fibers, 80 percent rubbed; weak thick platy structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; extremely acid; clear smooth boundary.
Oi2-3 to 12 inches; dark brown (7.5YR 3/2, broken face) fibric material pressed and rubbed; about 95 percent fibers, 90 percent rubbed; weak thick platy structure; soft, friable, nonsticky and nonplastic; few fine roots; extremely acid; abrupt smooth boundary.
0i3-12 to 60 inches; dark brown (7.5YR 4/4, broken face) fibric material, reddish yellow (7.5YR 7/6) pressed and rubbed; about 95 percent fibers, 90 percent rubbed; massive; soft, friable, nonsticky and nonplastic; extremely acid.

The estimated mean annual soil temperature is 47 to 50 degrees F.

The surface tier is muck, peat, or mucky peat. It has hue of 2.5YR or 5YR, value of 2 or 3 when moist, and chroma of 2 to 4 when moist. The subsurface tier has hue of 5YR to 10YR, and it has value and chroma of 3 to 7 when moist.

Oso series

The Oso series consists of moderately deep, moderately well drained soils on mountainsides and ridgetops. These soils formed in glacial till, volcanic ash, and material weathered from andesite. Slope is 3 to 90 percent. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 90 to 120 days.

Typical pedon of Oso gravelly loam, 3 to 15 percent slopes, 1,500 feet west and 1,700 feet north of the southeast corner of sec. 7, T. 28 N., R. 9 E.

O1-2 inches to 0; leaves, needles, twigs, and mosses.
A1-0 to 3 inches; black (10YR 2/1) gravelly loam, very dark brown (10YR 2/2) dry; moderate fine granular

structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; many fine interstitial pores; 20 percent pebbles; extremely acid; abrupt wavy boundary.

A2-3 to 5 inches; light brownish gray (10YR 6/2) gravelly loam, light gray (10YR 7/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; few fine tubular pores; 20 percent pebbles; very strongly acid; abrupt wavy boundary.

B21ir-5 to 9 inches; dark brown (7.5YR 4/4) gravelly loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common medium and coarse roots; common fine interstitial pores; 30 percent pebbles; strongly acid; clear wavy boundary.

B22-9 to 20 inches; yellowish brown (10YR 5/4) gravelly loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common medium and coarse roots; common fine interstitial pores; 20 percent pebbles; strongly acid; clear wavy boundary.

B3-20 to 29 inches; yellowish brown (10YR 5/4) gravelly loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few medium and coarse roots; few fine tubular pores; 35 percent pebbles; strongly acid; abrupt wavy boundary.

R-29 inches; unweathered andesite.

Depth to bedrock ranges from 20 to 40 inches. The control section is 5 to 35 percent coarse fragments.

The A1 horizon has hue of 10YR or 7.5YR and value of 2 or 3 when moist or dry. The A2 horizon has hue of 10YR or 7.5YR, value of 5 or 6 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has hue of 10YR, 7.5YR, or 5YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 3 to 6 when moist or dry. It is gravelly silt loam, cobbly loam, gravelly loam, silt loam, or loam.

Pastik series

The Pastik series consists of very deep, moderately well drained soils on terraces. These soils formed in lake sediment and volcanic ash. Slope is 0 to 50 percent. Elevation is 200 to 800 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typical pedon of Pastik silt loam, 0 to 8 percent slopes, 1,550 feet north and 1,200 feet east of the southwest corner of sec. 31, T. 28 N., R. 8 E. (fig. 5).

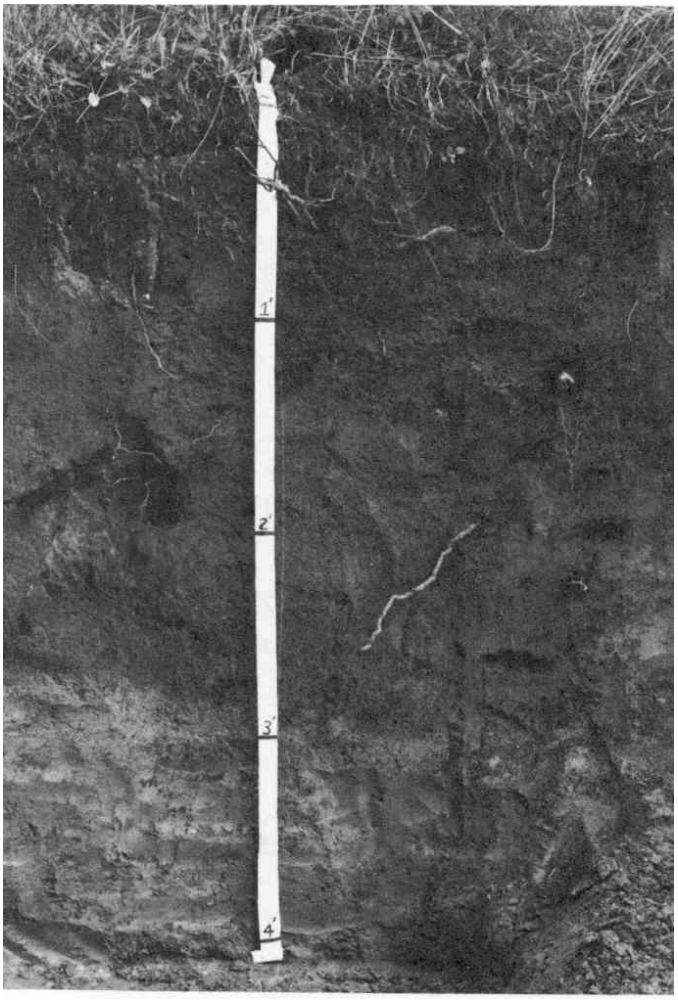

Figure 5.-Typical profile of Pastik silt loam, 0 to 8 percent slopes.

Ap-0 to 6 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 5/2) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine roots; common very fine and fine interstitial pores; slightly acid; abrupt smooth boundary.

B21-6 to 14 inches; dark brown (7.5YR 4/4) silt loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; few fine tubular pores; medium acid; clear wavy boundary.

B22-14 to 20 inches; yellowish brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; few medium distinct dark brown (7.5YR 4/4) mottles, light brown (7.5YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary;

common fine and medium roots; few very fine tubular pores and common fine tubular pores; medium acid; clear wavy boundary.

B23-20 to 29 inches; yellowish brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; few medium distinct dark brown (7.5YR 4/4) mottles, light brown (7.5YR 6/4) dry, and few medium distinct reddish yellow (7.5YR 6/6) mottles, reddish yellow (7.5YR 8/6) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; few fine tubular pores; medium acid; abrupt smooth boundary.

C-29 to 60 inches; light olive gray (5Y 6/2) silt loam, light gray (5Y 7/2) dry; few fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles, brownish yellow (10YR 6/6) and reddish yellow (7.5YR 6/6) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine tubular pores; medium acid.

The mean annual soil temperature at a depth of 20 inches is 47 to 51 degrees F. The solum is 20 to 40 inches thick. The 10- to 40-inch control section is 0 to 5 percent rock fragments.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 2 or 3 when moist or dry.

The B2 horizon has hue of 10YR or 7.5YR, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 3 to 5 when moist or dry. It is loam or silt loam.

The C horizon has hue of 5Y or 2.5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry. It is silt loam or silty clay loam.

Pilchuck series

The Pilchuck series consists of very deep, somewhat excessively drained soils on flood plains. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 20 to 800 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 200 days.

Typical pedon of Pilchuck loamy sand, 2,400 feet east and 300 feet south of the northwest corner of sec. 10, T. 27 N., R. 7 E.

A1-0 to 2 inches; dark grayish brown (2.5Y 4/2) loamy sand, light brownish gray (2.5Y 6/2) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine roots; few fine discontinuous pores; slightly acid; abrupt wavy boundary.

C1-2 to 4 inches; olive gray (5Y 4/2) fine sandy loam, light olive gray (5Y 6/2) dry; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common fine roots; slightly acid; abrupt *wavy* boundary.

C2-4 to 31 inches; black (10YR 2/1), dark gray (10YR 4/1), grayish brown (10YR 5/2), light gray (10YR 7/2), and yellow (10YR7/6) loamy sand, black (10YR 2/1), yellow (10YR 7/6), dark gray (10YR 4/1), and white (10YR 8/2) dry; single grain; loose; between depths of 15 and 17 inches is an old erosional surface that has a mat of roots; common fine to medium roots and few coarse roots; olive yellow (2.5Y 6/6) mica flakes less than 5 millimeters across; slightly acid; clear smooth boundary.

C3-31 to 34 inches; light gray (10YR 7/2), gray (10YR 5/1), very dark gray (10YR 3/1), and very pale brown (10YR 7/4) fine sand, light gray (10YR 7/2), dark gray (10YR 4/1), very pale brown (10YR 7/4), and white (10YR 8/2) dry; massive; loose; scattered pieces of bark less than 50 millimeters across; common fine to medium roots and few coarse roots; olive yellow (2.5Y 6/6) mica flakes less than 5 millimeters across; slightly acid; clear smooth boundary.

C4-34 to 50 inches; light gray (10YR 7/1), very dark grayish brown (10YR 3/2), yellow (10YR 7/6), and very pale brown (10YR 7/4) fine sand, light gray (10YR 7/1), dark gray (10YR 4/1), gray (10YR 5/1), and light yellowish brown (10YR 6/4) dry; single grain; loose; few medium and coarse roots; olive yellow (2.5Y 6/6) mica flakes less than 5 millimeters across; slightly acid; abrupt wavy boundary.

C5-50 to 60 inches; light gray (10YR 7/1), very dark grayish brown (10YR 3/2), yellow (10YR 7/6), and very pale brown (10YR 7/4) gravelly sand, light gray (10YR 7/1), dark gray (10YR 4/1), gray (10YR 5/1), and light yellowish brown (10YR 6/4) dry; olive yellow (2.5Y 6/6) mica flakes less than 5 millimeter across; 30 percent rounded granite pebbles; slightly acid.

The mean annual soil temperature at a depth of 20 inches ranges from 48 to 52 degrees F. The control section is 0 to 15 percent coarse fragments.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4 when moist and 3 to 6 when dry, and chroma of 1 or 2 when moist or dry.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 8 when moist or dry, and chroma of 1 to 6 when moist or dry. The C2 through C5 horizons are loamy sand to fine sand. The lower part of the C horizon is gravelly or very gravelly.

Potchub series

The Potchub series consists of moderately deep, moderately well drained soils on mountainsides and ridgetops. These soils formed in glacial till and volcanic ash. Slope is 3 to 90 percent. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41

degrees F, and the average frost-free season is 90 to 100 days.

Typical pedon of Potchub silt loam, 3 to 30 percent slopes, 2,000 feet west and 600 feet north of the southeast corner of sec. 34, T. 32 N., R. 7 E.

O1-9 to 7 inches; leaves, needles, and twigs.
O2-7 inches to 0; decomposed organic litter.
A1-0 to 7 inches; very dark brown (7.5YR 2/2) silt loam, dark brown (7.5YR 3/2) dry; moderate coarse granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine, fine, and medium roots and common coarse roots; many fine interstitial pores; extremely acid; abrupt wavy boundary.
A2-7 to 10 inches; pinkish gray (7.5YR 7/2) silt loam, pinkish white (7.5YR 8/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine and medium roots and common coarse roots; few fine tubular pores; 5 percent pebbles; very strongly acid; abrupt wavy boundary.
B21hir-10 to 13 inches; dark reddish brown (5YR 3/3) silt loam, reddish brown (5YR 4/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; few fine tubular pores; 5 percent pebbles; very strongly acid; abrupt wavy boundary.
B22hir-13 to 17 inches; strong brown (7.5YR 5/6) silt loam, reddish yellow (7.5YR 7/6) dry; reddish brown (5YR 4/4) coatings on peds, light reddish brown (5YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; few fine tubular pores; 5 percent pebbles; medium acid; abrupt wavy boundary.
B23-17 to 22 inches; strong brown (7.5YR 5/6) silt loam, light yellowish brown (10YR 6/4) dry; dark brown (7.5YR 4/4) coatings in cracks, dark yellowish brown (10YR 4/4) dry; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few medium roots; few fine tubular pores; 5 percent pebbles; medium acid; clear wavy boundary.
B3-22 to 34 inches; dark brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; common fine faint strong brown (7.5YR 5/6) mottles, light brown (7.5YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine tubular pores; 10 percent pebbles; medium acid; abrupt smooth boundary.
IICr-34 to 60 inches; olive (5Y 5/3) dense glacial till that breaks to gravelly sandy loam, light olive gray (5Y 6/2) dry; extremely hard, very firm; few fine tubular pores; 20 percent pebbles; medium acid.

The mean annual soil temperature at a depth of 20 inches is 41 to 43 degrees F. Depth to the dense glacial till ranges from 20 to 40 inches. The control section averages less than 15 percent coarse fragments.

The A1 horizon has hue of 10YR or 7.5YR, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 1 or 2 when moist or dry. The A2 horizon has hue of 10YR or 7.5YR, value of 5 to 7 when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist or dry. The B horizon is silt loam or loam. The C horizon has hue of 5Y or 2.5Y, value of 5 or 6 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist or dry.

Puget series

The Puget series consists of very deep, poorly drained soils in depressional areas on flood plains. These soils formed in alluvium. Slope is 0 to 2 percent. Elevation ranges from near sea level to 650 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typical pedon of Puget silty clay loam, 188 feet north and 1,100 feet east of the southwest corner of sec. 8, T. 31 N., R. 5 E.

Ap-0 to 9 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; moderate medium and coarse granular structure; very hard, friable, sticky and plastic; many fine roots; many fine and medium tubular pores and many micro interstitial pores; neutral; abrupt smooth boundary.
C1-9 to 32 inches; olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/1) dry, many medium distinct dark reddish brown (5YR 3/3) mottles on peds and dark yellowish brown (10YR 4/4) mottles around root channels; massive parting to very coarse angular blocky structure; very hard, firm, sticky and plastic; many fine roots on peds and common fine roots in peds; few medium tubular pores; 5 to 10 percent woody fragments; slightly acid; abrupt smooth boundary.
C2-32 to 38 inches; gray (5Y 5/1) silty clay loam, gray (5Y 6/1) dry; many medium prominent dark reddish brown (2.5YR 2/4) mottles on peds and dark yellowish brown (10YR 4/4) mottles around root channels; massive; very hard, firm, sticky and plastic; few fine roots; few fine tubular pores; slightly acid; abrupt smooth boundary.
C3-38 to 60 inches; gray (5Y 5/1) silty clay loam, light gray (5Y 7/2) dry; many medium prominent dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; hard, friable, sticky and plastic; few fine roots; many fine tubular pores; slightly acid.

The mean annual soil temperature at a depth of 20 inches is 47 to 50 degrees F. The control section averages less than 5 percent coarse fragments, less

than 15 percent fine and coarse sand, and 18 to 35 percent clay.

The A horizon has hue of 2.5Y to 5Y, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 1 or 2 when moist or dry. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 1 or 2 when moist or dry. It is silt loam, silty clay loam, or silty clay.

Puyallup series

The Puyallup series consists of very deep, well drained soils on stream terraces. These soils formed in alluvium of mixed origin. Slope is 0 to 3 percent. Elevation is 20 to 500 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 150 to 200 days.

Typical pedon of Puyallup fine sandy loam, 2,540 feet south and 700 feet east of the northwest corner of sec. 5, T. 27 N., R. 8 E.

Ap-0 to 10 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; few fine tubular pores and common fine interstitial pores; slightly acid; abrupt smooth boundary.

C1-10 to 16 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; common fine tubular and interstitial pores; slightly acid; abrupt smooth boundary.

C2-16 to 30 inches; olive brown (2.5Y 4/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; many medium distinct light brownish gray (2.5Y 6/2) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; common fine tubular and interstitial pores; slightly acid; abrupt smooth boundary.

C3-30 to 60 inches; dark grayish brown (2.5Y 4/2) sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; few fine roots; many fine interstitial pores; neutral.

The mean annual soil temperature at a depth of 20 inches is 47 to 50 degrees F.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 1 to 3 when moist or dry.

The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. The lower part of the C horizon ranges from loamy sand to sand. In some pedons it is gravelly in the lower part.

Ragnar series

The Ragnar series consists of very deep, well drained soils on outwash plains. These soils formed in glacial outwash. Slope is 0 to 15 percent. Elevation is 300 to 1,000 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typical pedon of Ragnar fine sandy loam, 0 to 8 percent slopes, 188 feet north and 1,375 feet west of the southeast corner of sec. 22, T. 31 N., R. 5 E.

O2-1 1/2 inches to 0; partially decomposed leaves, needles, and twigs.

A1-0 to 2 inches; dark brown (7.5YR 3/2) fine sandy loam, brown (7.5YR 5/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine, medium, and coarse roots; many micro interstitial pores; slightly acid; clear smooth boundary.

B21ir-2 to 7 inches; dark brown (7.5YR 4/4) sandy loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; many very fine pores; many semiround iron concretions 1 /2 to 1 millimeter in diameter; slightly acid; clear smooth boundary.

B22ir-7 to 24 inches; dark brown (7.5YR 4/4) sandy loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; many very fine interstitial pores; slightly acid; clear smooth boundary.

C1-24 to 31 inches; dark yellowish brown (10YR 4/4) loamy sand, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; common fine and medium roots; slightly acid; abrupt smooth boundary.

IIC2-31 to 60 inches; dark gray (10YR 4/1) sand, gray (10YR 6/1) dry; single grain; loose; few fine and medium roots; slightly acid.

The mean annual soil temperature at a depth of 20 inches ranges from 47 to 52 degrees F. The control section is 0 to 15 percent coarse fragments.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 1 or 2 when moist or dry.

The B horizon has hue of 10YR or 7.5YR, value of 3 .to 5 when moist and 4 to 6 when dry, and chroma of 4 to 6 when moist or dry. It is 0 to 5 percent iron concretions and 0 to 15 percent coarse fragments.

The C horizon has hue or 10YR or 2.5Y, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 1 to 4 when moist or dry. It is 0 to 15 percent coarse fragments.

Rober series

The Rober series consists of very deep, moderately well drained soils on terraces and terrace escarpments. These soils formed in lacustrine sediment and volcanic ash. Slope is 0 to 65 percent. Elevation is 800 to 1,800 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 130 to 150 days.

Typical pedon of Rober silt loam, 0 to 15 percent slopes, 1,700 feet east and 20 feet north of the southwest corner of sec. 12, T. 30 N., R. 7 E.

O1-2 1/2 inches to 1 inch; leaves, needles, and mosses.

O2-1 inch to 0; partially decomposed litter.

A1-0 to 3 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and nonplastic; weakly smeary; common fine, medium, and coarse roots; common fine tubular pores; strongly acid; abrupt smooth boundary.

B21ir-3 to 7 inches; dark reddish brown (5YR 3/3 and 3/4) silt loam, brown (7.5YR 5/4) and dark brown (7.5YR 4/4) dry; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; common fine tubular pores; medium acid; abrupt smooth boundary.

B22ir-7 to 13 inches; reddish brown (5YR 4/4) and dark brown (7.5YR 4/4) silt loam, brown (7.5YR 5/4) and strong brown (7.5YR 5/6) dry; common medium dark reddish brown iron and organic stains on peds; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; few fine and medium roots; common fine tubular pores; medium acid; clear smooth boundary.

B3-13 to 22 inches; yellowish brown (10YR 5/4) silt loam, very pale brown and pale brown (10YR 7/3 and 6/3) dry; common fine brown iron and organic stains on peds; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and medium roots; common fine tubular pores; slightly acid; clear smooth boundary.

C1-22 to 30 inches; grayish brown (10YR 5/2) and brown (10YR 5/3) silty clay loam, light gray (10YR 7/2) and very pale brown (10YR 7/3) dry; common medium faint dark yellowish brown (10YR 4/4) mottles; massive; finely laminated; hard, friable, slightly sticky and plastic; weakly smeary; very few fine roots; few fine tubular pores; medium acid; gradual smooth boundary.

C2-30 to 60 inches; grayish brown (10YR 5/2) and brown (10YR 5/3) silty clay loam, light gray (10YR 7/2) and very pale brown (10YR 7/3) dry; common medium faint dark yellowish brown (10YR 4/4) mottles; massive; hard, friable, slightly sticky and plastic; finely stratified with silt loam; few fine tubular pores; slightly acid.

The mean annual soil temperature at a depth of 20 inches is 45 to 47 degrees F. The solum is 20 to 40 inches thick. The 10- to 40-inch control section is 0 to 5 percent rock fragments.

The A horizon has hue of 10YR or 7.5YR, value of 2 to 5 when moist and 3 to 6 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has value of 3 to 6 when moist and 4 to 7 when dry, and it has chroma of 3 to 6 when moist or dry. It is silt loam or loam.

The C horizon has hue of 10YR, 5Y, or 2.5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry.

Skykomish series

The Skykomish series consists of very deep, somewhat excessively drained soils on terraces, terrace escarpments, and outwash plains. These soils formed in glacial outwash and volcanic ash. Slope is 0 to 30 percent. Elevation is 400 to 1,600 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 47 degrees F, and the average frost-free season is 85 to 125 days.

Typical pedon of Skykomish gravelly loam, 0 to 30 percent slopes, 2,000 feet east and 2,150 feet south of the northwest corner of sec. 25, T. 31 N., R. 7 E.

O1-4 to 3 inches; forest litter of leaves and twigs.

O2-3 inches to 0; decomposed forest litter.

B21hir-0 to 2 1/2 inches; dark reddish brown (5YR 3/3) gravelly loam, dark brown (7.5YR 4/4) dry; black (5YR 2/1) stains on 70 percent of peds; moderate coarse subangular blocky structure; slightly hard, firm, slightly sticky and nonplastic; weakly smeary; common very fine, fine, medium, and coarse roots; common very fine discontinuous pores; 20 percent rounded and angular pebbles; very strongly acid; abrupt smooth boundary.

B22ir-2 1/2 to 12 inches; yellowish red (5YR 4/8) gravelly loam, light brown (7.5YR 6/4) dry; weak coarse subangular blocky structure; slightly hard, firm, slightly sticky and nonplastic; weakly smeary; few very fine, fine, medium, and coarse roots; common very fine discontinuous pores; 20 percent rounded and angular pebbles; medium acid; clear wavy boundary.

B23ir-12 to 19 inches; yellowish red (5YR 4/6) very gravelly fine sandy loam, reddish yellow (7.5YR 6/6) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; weakly smeary; few very fine and fine roots and

common medium and coarse roots; common very fine discontinuous pores; 40 percent rounded and angular pebbles; medium acid; abrupt irregular boundary.

IIC1-19 to 28 inches; dark yellowish brown (10YR 4/4) extremely gravelly loamy coarse sand, light yellowish brown (10YR 6/4) dry; single grain; loose; few very fine, fine, and medium roots; 65 percent pebbles and 5 percent cobbles; very compact discontinuous layer 1 inch to 2 inches thick in upper part of horizon; medium acid; abrupt wavy boundary.

IIC2-28 to 60 inches; very dark grayish brown (10YR 3/2) extremely gravelly coarse sand, olive (5Y 5/3) dry; single grain; loose; 65 percent pebbles and 5 percent cobbles; medium acid.

The mean annual soil temperature at a depth of 20 inches is 44 to 47 degrees F. The solum is 14 to 31 inches thick. The upper part of the 10- to 40-inch control section is 35 to 60 percent rock fragments, and the lower part is 50 to 80 percent rock fragments.

The Bir horizon has hue of 10YR to 5YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 3 to 8 when moist or dry. It is gravelly loam, gravelly sandy loam, very gravelly loam, very gravelly fine sandy loam, or very gravelly sandy loam.

The IIC horizon has hue of 5Y to 10YR, value of 3 to 6 when moist and 3 to 7 when dry, and chroma of 2 to 4 when moist and 3 to 6 when dry. It is extremely gravelly coarse sand to very gravelly loamy sand.

Snohomish series

The Snohomish series consists of very deep, poorly drained soils on flood plains. These soils formed in alluvium underlain by peat and muck. Slope is 0 to 2 percent. Elevation ranges from near sea level to 150 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typical pedon of Snohomish silt loam, 1,500 feet west and 1,250 feet south of the northeast corner of sec. 22, T. 29 N., R. 5 E.

Ap-0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate fine granular structure; slightly hard, friable, nonsticky and slightly plastic; many fine and medium roots; many fine and medium interstitial pores; very strongly acid; abrupt smooth boundary.

B21g-6 to 14 inches; gray (5Y 6/1) silty clay loam, gray (5Y 6/1) dry; many fine, medium, and coarse prominent dark olive (5Y 3/3) and dark reddish brown (2.5YR 3/4) mottles on peds, pale olive (5Y 6/4) and reddish brown (5YR 4/4) dry; weak fine and medium subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots; few fine tubular pores and common very fine tubular pores; very strongly acid; clear wavy boundary.

B22g-14 to 29 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, light brownish gray (10YR 6/2) dry; many fine distinct black (10YR 2/1), gray (N 6/0), and dark reddish brown (5YR 3/2) mottles, very dark gray (10YR 3/1) and dark brown (7.5YR 4/4) dry; weak coarse and medium platy structure parting to weak fine subangular blocky; hard, friable, slightly sticky and plastic; common fine roots; common fine tubular pores; very strongly acid; clear smooth boundary.

IIOe1-29 to 36 inches; dark reddish brown (5YR 2/2, on broken face and rubbed) hemic material; about 65 percent fibers, about 20 percent when rubbed; weak medium platy structure; slightly hard, friable, nonsticky and slightly plastic; 3 percent woody fragments; very strongly acid; abrupt smooth boundary.

IIOe2-36 to 44 inches; very dark grayish brown (10YR 3/2, on broken face and rubbed) hemic material; about 50 percent fibers, 15 percent when rubbed; massive; hard, friable, nonsticky and slightly plastic; 2 percent woody fragments 1 /4 to 1 inch in diameter; medium acid; gradual smooth boundary.

IIOe3-44 to 60 inches; very dark gray (10YR 3/1, rubbed) and very dark grayish brown (10YR 3/2, rubbed) hemic material, gray (10YR 6/1, on broken face and rubbed) dry; about 60 percent fibers, about 20 percent when rubbed; massive; hard, friable, nonsticky and slightly plastic; 2 percent woody fragments 1 /4 to 1 inch in diameter; medium acid.

The profile is 0 to 10 percent coarse fragments.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 1 or 2 when moist or dry. The Bg horizon has hue of 10YR, 5YR, 5Y, or 2.5Y, value of 3 to 6 when moist and 3 to 7 when dry, and chroma of 1 or 2 when moist or dry. It is silty clay loam or silty clay.

Depth to the Oe horizon is 17 to 32 inches. This horizon is stratified, sedimentary, and woody, and it consists of sedges or peat with thin lenses of silty clay loam.

The Snohomish soils in this survey are a taxadjunct to the Snohomish series because they show evidence of volcanic ash in the upper part. This difference does not affect the use and management of the soils.

Sulsavar series

The Sulsavar series consists of very deep, well drained soils on terraces and alluvial fans. These soils formed in volcanic ash and alluvium. Slope is 0 to 8 percent. Elevation is 400 to 1,200 feet. The average annual precipitation is about 60 inches, the average

annual air temperature is about 46 degrees F, and the average frost-free season is 120 to 180 days.

Typical pedon of Sulsavar gravelly loam, 0 to 8 percent slopes, 1,500 feet south and 2,700 feet west of the northeast corner of sec. 25, T. 29 N., R. 7 E.

O1-1 /2 inch to 0; leaves, needles, twigs, and mosses.
A1-0 to 3 inches; dark brown (10YR 3/3) gravelly loam, yellowish brown (10YR 5/4) dry; weak fine granular structure; slightly hard, friable, nonsticky and slightly plastic; common fine roots; common fine tubular pores; 25 percent rounded pebbles; medium acid; abrupt smooth boundary.
B21-3 to 13 inches; dark brown (10YR 4/3) gravelly sandy loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few fine roots; common fine and medium tubular pores; 25 percent rounded pebbles; micaceous; medium acid; abrupt smooth boundary.
B22-13 to 18 inches; yellowish brown (10YR 5/4) silt loam, very pale brown (10YR 7/3) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; common medium tubular pores and very few coarse tubular pores; 10 percent rounded pebbles; micaceous; slightly acid; abrupt smooth boundary.
B23-18 to 24 inches; yellowish brown (10YR 5/4) gravelly loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; 30 percent rounded pebbles; micaceous; slightly acid; abrupt smooth boundary.
B3-24 to 33 inches; yellowish brown (10YR 5/4) gravelly loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; 30 percent rounded pebbles; very micaceous; slightly acid; abrupt smooth boundary.
C1-33 to 38 inches; dark brown (10YR 4/3) sandy loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few fine roots; few fine tubular pores; 10 percent pebbles; micaceous; neutral; abrupt smooth boundary.
C2-38 to 60 inches; brown (10YR 5/3) stratified very gravelly loamy sand and gravelly sandy loam, pale brown (10YR 6/3) dry; single grain; loose; 50 percent pebbles in loamy sand strata and 20 percent pebbles in sandy loam strata; neutral.

The mean annual soil temperature at a depth of 20 inches is 47 to 50 degrees F. The control section is 15 to 35 percent coarse fragments.

The A1 horizon has hue of 10YR or 7.5YR, value of 2 to 4 when moist and 3 to 6 when dry, and chroma of 2 to 5 when moist or dry.

The B horizon has hue of 10YR or 7.5YR and chroma of 3 to 6 when moist or dry. It is stratified with individual layers of gravelly loam, gravelly fine sandy loam, gravelly sandy loam, or gravelly silt loam.

The C horizon has hue of 10YR, 5Y, or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 to 5 when moist or dry. It is stratified with individual layers of very gravelly loamy sand to loam.

Sultan series

The Sultan series consists of very deep, moderately well drained soils on flood plains. These soils formed in alluvium. Slope is 0 to 2 percent. Elevation is 10 to 120 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 150 to 200 days.

Typical pedon of Sultan silt loam, 500 feet south and 50 feet east of the north quarter corner of sec. 24, T. 28 N., R. 5 E.

Ap-0 to 12 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and plastic; common fine roots; common fine tubular pores and few medium tubular pores; neutral; clear smooth boundary.
C1-12 to 28 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; weak moderate subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; few very fine, fine, and coarse tubular pores; neutral; gradual smooth boundary.
C2-28 to 42 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; very few fine faint mottles; massive; slightly hard, very friable, nonsticky and slightly plastic; few medium roots; common fine and medium pores; finely stratified with lenses of loamy fine sand 1/4 inch thick; neutral; gradual smooth boundary.
C3g-42 to 60 inches; olive brown (2.5Y 4/4) fine sandy loam, light brownish gray (2.5Y 6/2) dry; few fine faint light olive brown (2.5Y 5/4) mottles; massive; soft, very friable, nonsticky and nonplastic; many very fine interstitial pores; finely stratified with strata of loamy fine sand 1/2 to 1 inch thick; neutral.

The control section is less than 5 percent coarse fragments, less than 15 percent fine and coarse sand, and 20 to 35 percent clay.

The A horizon has value of 3 or 4 when moist and 4 to 6 when dry. The C horizon has hue of 2.5Y and 5Y, value of 4 or 5 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. The lower part is stratified with loamy very fine sand or sand, or both.

Sultan Variant

Sultan Variant consists of very deep, well drained soils on flood plains. These soils formed in alluvium. Slope is

0 to 3 percent. Elevation is 40 to 400 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 49 degrees F, and the average frost-free season is 150 to 200 days.

Typical pedon of Sultan Variant silt loam, 1,500 feet north and 400 feet east of the southwest corner of sec. 35, T. 28 N., R. 8 E.

Ap-0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (2.5Y 5/2) dry; weak coarse granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; medium acid; abrupt smooth boundary.

B21-9 to 18 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak coarse subangular blocky structure; soft, friable, slightly sticky and slightly plastic; discontinuous strata of loamy very fine sand 1/2 to 1 inch thick throughout horizon; common very fine and fine roots and few medium and coarse roots; medium acid; clear smooth boundary.

B22-18 to 25 inches; olive brown (2.5Y 4/4) silt loam, light brownish gray (2.5Y 6/2) dry; common fine faint grayish brown and light olive brown (2.5Y 5/2 and 5/6) mottles; weak coarse subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine and fine roots; medium acid; abrupt smooth boundary.

IIC1-25 to 34 inches; olive brown (2.5Y 4/4) loamy fine sand, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; medium acid; abrupt smooth boundary.

IIC2-34 to 40 inches; olive gray (5Y 5/2) sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; slightly acid; abrupt smooth boundary.

IIC3-40 to 50 inches; olive gray (5Y 5/2) coarse sand, multicolored dry; single grain; loose; slightly acid; abrupt smooth boundary.

IIC4-50 to 60 inches; multicolored very gravelly coarse sand; single grain; loose; 40 percent pebbles; slightly acid.

The mean annual soil temperature at a depth of 20 inches is 47 to 52 degrees F. Depth to loamy fine sand, sand, or very gravelly sand is 20 to 32 inches.

The A horizon has hue of 10YR, 5Y, or 2.5Y, value of 2 to 4 when moist and 4 to 6 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has hue of 5Y or 2.5Y, value of 2 to 4 when moist and 4 to 6 when dry, and chroma of 1 or 2 when moist or dry. It is stratified with individual layers of loamy fine sand to silt loam.

The IIC horizon has hue of 2.5Y or 5Y, value of 4 to 7 when moist or dry, and chroma of 2 to 4 when moist or dry. The lower part is 35 to 55 percent coarse fragments.

Sumas series

The Sumas series consists of very deep, poorly drained soils on flood plains. These soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 10 to 500 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 210 days.

Typical pedon of Sumas silt loam, 1,375 feet north and 62 feet west of the southeast corner of sec. 25, T. 28 N., R. 5 E.

Ap-0 to 8 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; few fine tubular pores; neutral; abrupt smooth boundary.

A12-8 to 14 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; slightly acid; abrupt smooth boundary.

C1g-14 to 21 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; many fine and medium distinct olive brown (2.5Y 4/4) and olive gray (5Y 5/2) mottles, light olive brown (2.5Y 5/4) and light olive gray (5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; very few fine tubular pores; slightly acid; abrupt smooth boundary.

C2g-21 to 24 inches; olive gray (5Y 5/2) fine sandy loam, light olive gray (5Y 6/2) dry; many medium and fine distinct olive brown (2.5Y 4/4) mottles; massive; slightly hard, very friable, nonsticky and nonplastic; very few fine tubular pores; neutral; clear smooth boundary.

IIC3-24 to 60 inches; pale yellow (2.5Y 7/4), olive brown (2.5Y 4/4), and very dark grayish brown (2.5Y 3/2) sand, pale yellow (2.5Y 7/3), light yellowish brown (2.5Y 6/4), and dark grayish brown (2.5Y 4/2) dry; single grain; loose; many fine interstitial pores; 5 percent fine pebbles; neutral.

The mean annual soil temperature at a depth of 20 inches is 48 to 52 degrees F. Sand or gravelly sand is at a depth of 20 to 32 inches. The upper part of the control section is 10 to 18 percent clay and less than 15 percent fine sand or coarser material. The lower part is sand or gravelly sand.

The A horizon has hue of 2.5Y, 5Y, or 10YR, value of 2 to 4 when moist and 4 to 6 when dry, and chroma of 2 or 3 when moist or dry.

The C1g horizon has value of 2 to 5 when moist and 4 to 6 when dry, and it has chroma of 1 or 2 when moist

or dry. It is fine sandy loam or silt loam and has fine and medium distinct mottles.

The IIC horizon has hue of 2.5Y or 5Y, value of 3 to 7 when moist or dry, and chroma of 2 to 4 when moist or dry. It is loamy sand to gravelly sand.

The Sumas soils in this survey area are a taxadjunct to the Sumas series because the upper part of the control section averages less than 18 percent clay. This difference does not affect the use and management of the soils.

Tokul series

The Tokul series consists of moderately deep, moderately well drained soils on till plains. These soils formed in glacial till and volcanic ash. Slope is 0 to 25 percent. Elevation is 200 to 800 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 46 degrees F, and the average frost-free season is 140 to 200 days.

Typical pedon of Tokul gravelly loam, 0 to 8 percent slopes, 2,200 feet east and 1,050 feet north of the southwest corner of sec. 6, T. 28 N., R. 7 E. (fig. 6).

O1-1 1/2 inches to 1/2 inch; forest litter of leaves and twigs.

O2-1/2 inch to 0; black (10YR 2/1) decomposed litter.

A1-0 to 3 1/2 inches; dark brown (7.5YR 3/2) gravelly loam, yellowish brown (10YR 5/4) dry; moderate medium granular structure; soft, very friable, .slightly sticky and nonplastic; common very fine, fine, and medium roots and few coarse roots; common very fine discontinuous pores; 5 percent medium rounded concretions and 15 percent pebbles; medium acid; abrupt wavy boundary.

B21-3 1/2 to 7 inches; dark brown (7.5YR 4/4) gravelly loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine, fine, and medium roots and few coarse roots; common very fine discontinuous pores; 5 percent fine and medium rounded concretions and 15 percent pebbles; slightly acid; clear smooth boundary.

B22-7 to 15 inches; strong brown (7.5YR 5/6) gravelly loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine, fine, and medium roots and few coarse roots; common very fine discontinuous pores; 5 percent fine rounded concretions and 15 percent pebbles; medium acid; clear wavy boundary.

B3-15 to 22 inches; dark yellowish brown (10YR 4/4) gravelly loam, very pale brown (10YR 7/4) dry; common medium distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine, fine, medium, and coarse roots; common very fine discontinuous pores; 3 percent fine rounded concretions, 10 percent cobbles, and 20 percent pebbles; slightly acid; clear smooth boundary.

C1-22 to 31 inches; light olive brown (2.5Y 5/4) gravelly fine sandy loam, pale yellow (2.5Y 8/4) dry;

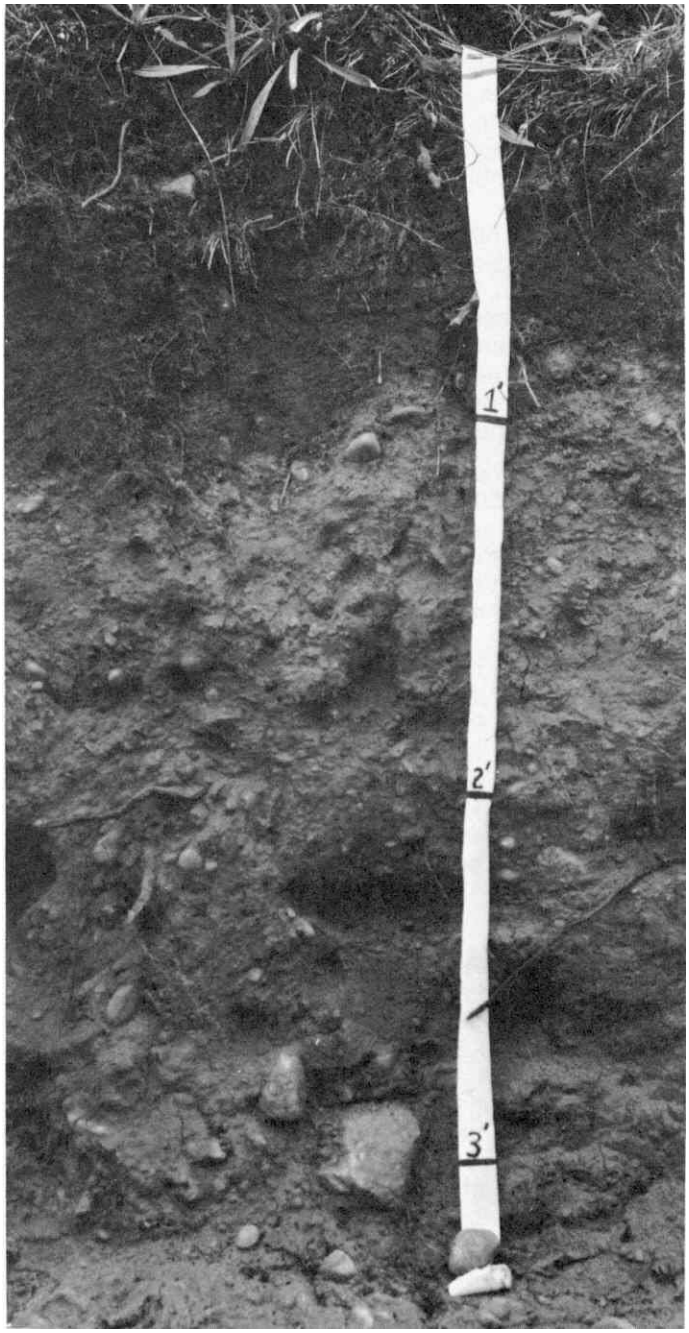

Figure 6.-Typical profile of Tokul gravely loam, 0 to 8 percent slopes.

common fine distinct yellowish brown (10YR 5/8) mottles; massive; slightly hard, friable, slightly sticky and nonplastic; very weakly smeary; few very fine, fine, medium, and coarse roots; common very fine discontinuous pores; 1 percent fine irregularly shaped concretions, 5 percent cobbles, and 25 percent pebbles; medium acid; abrupt smooth boundary.

IIC2sim-31 to 60 inches; weakly cemented duripan that breaks to dark grayish brown (2.5Y 4/2) gravelly sandy loam, light gray (2.5Y 7/2) dry; common medium distinct yellowish brown (10YR 5/8) mottles; massive; hard, extremely firm; extremely hard in places; 35 percent pebbles; a very thin discontinuous silica layer (1/2 millimeter thick) on surface of horizon; medium acid.

The mean annual soil temperature at a depth of 20 inches is 47 to 50 degrees F. The duripan is at a depth of 20 to 40 inches. The control section is more than 15 percent to less than 35 percent rock fragments.

The A horizon has value of 2 to 4 when moist and 4 or 5 when dry, and it has chroma of 1 to 4 when moist or dry.

The B horizon has value of 4 to 6 when moist and 5 to 7 when dry, and it has chroma of 4 to 6 when moist or dry. It is gravelly loam, gravelly silt loam, or gravelly sandy loam, and is 5 percent or less concretions.

The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 5 to 8 when dry, and it has chroma of 2 to 4 when moist or dry. It is gravelly loamy sand, gravelly fine sandy loam, or gravelly loam.

Verlot series

The Verlot series consists of moderately deep, moderately well drained soils on mountainsides and ridgetops. These soils formed in glacial till and volcanic ash. Slope is 3 to 25 percent. Elevation is 2,800 to 4,000 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free season is 90 to 100 days.

Typical pedon of Verlot mucky silt loam, 3 to 25 percent slopes, about 12 miles east of Arlington, 2,200 feet west and 180 feet south of the northeast corner of sec. 35, T. 32 N., R. 7 E. (fig. 7).

O1-1 1/2 inches to 0; partially decomposed leaves, twigs, and needles; abrupt smooth boundary.

A1-0 to 10 inches; black (10YR 2/1) mucky silt loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; many fine interstitial pores; strongly acid; abrupt wavy boundary.

A2-10 to 16 inches; brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; black (10YR 2/1) organic coatings on peds, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; few fine tubular pores; strongly acid; abrupt wavy boundary.

Figure 7.-Typical profile of Verlot mucky silt loam, 3 to 25 percent slopes.

B21hir-16 to 21 inches; reddish brown (5YR 4/4) silt loam, light reddish brown (5YR 6/4) dry; black (5YR 2/1) organic coatings on peds, dark reddish gray (5YR 4/2) dry; common fine and medium faint yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and medium roots; 5 percent rounded

granitic pebbles and 5 percent concretions; strongly acid; gradual wavy boundary.

B22hir-21 to 26 inches; dark brown (7.5YR 4/4) gravelly loam, light brown (7.5YR 6/4) dry; common fine distinct dark reddish brown (5YR 3/3) mottles, reddish brown (5YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and medium roots; 20 percent pebbles; strongly acid; gradual wavy boundary.

B23-26 to 30 inches; dark brown (10YR 4/3) gravelly loam, pale brown (10YR 6/3) dry; common medium distinct dark reddish brown (5YR 3/2) mottles, reddish gray (5YR 5/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and medium roots; 20 percent pebbles; strongly acid; gradual wavy boundary.

B3-30 to 35 inches; dark brown (10YR 4/3) gravelly loam, pale brown (10YR 6/3) dry; many medium distinct very dusky red (2.5YR 2/2) mottles, dusky red (2.5YR 3/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine roots matted on top of the dense till; few fine tubular pores; 20 percent pebbles; strongly acid; abrupt smooth boundary.

IICr-35 to 60 inches; olive brown (2.5Y 4/4) and dark grayish brown (2.5Y 4/2) dense glacial till that breaks to gravelly loamy sand, light yellowish brown (2.5Y 6/4) and light brownish gray (2.5Y 6/2) dry; massive; hard, firm, nonsticky and nonplastic; 20 percent pebbles; strongly acid.

Thickness of the solum and depth to the dense glacial till are 20 to 40 inches. The mean annual soil temperature at a depth of 20 inches is 41 to 43 degrees F. The control section is 5 to 25 percent coarse fragments.

The A1 horizon has hue of 5YR, 7.5YR, or 10YR, and it has value of 2 or 3 when moist and 3 to 5 when dry. The A2 horizon has hue of 7.5YR or 10YR, value of 5 or 6 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has value of 3 to 6 when moist and 4 to 7 when dry, and it has chroma of 2 to 4 when moist or dry. The upper part of the horizon is loam or silt loam, and the lower part is gravelly loam or gravelly sandy loam.

The IICr horizon has hue of 2.5Y to 7.5YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist or dry. It is dense glacial till that breaks down to gravelly loamy sand or gravelly sandy loam.

Winston series

The Winston series consists of very deep, somewhat excessively drained soils on terraces, terrace escarpments, and outwash plains. These soils formed in glacial outwash or old alluvium and volcanic ash. Slope is 0 to 30 percent. Elevation is 200 to 900 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 140 to 200 days.

Typical pedon of Winston gravelly loam, 0 to 3 percent slopes, 1,200 feet west and 1,250 feet north of the southeast corner of sec. 3, T. 28 N., R. 7 E.

O1-2 inches to 1/2 inch; partially decomposed needles, leaves, and twigs.

O2-1/2 inch to 0; black (10YR 2/1) decomposed litter.

A1-0 to 2 1/2 inches; dark brown (7.5YR 3/2) gravelly loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; common very fine, fine, medium, and coarse roots; common very fine vesicular pores and few very fine discontinuous tubular pores; 20 percent rounded pebbles; strongly acid; abrupt smooth boundary.

B21-2 1/2 to 7 inches; dark brown (7.5YR 4/3) gravelly loam, yellowish brown (10YR 5/6) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; common very fine, fine, and medium roots and few coarse roots; few very fine discontinuous pores; 20 percent rounded pebbles; slightly acid; clear smooth boundary.

B22-7 to 10 inches; strong brown (7.5YR 5/6) gravelly loam, brownish yellow (10YR 6/6) dry; weak coarse subangular blocky structure; soft, friable, slightly sticky and nonplastic; weakly smeary; common very fine and fine roots and few medium and coarse roots; few very fine discontinuous pores; 20 percent rounded pebbles; slightly acid; clear wavy boundary.

B3-10 to 16 inches; yellowish brown (10YR 5/6) gravelly fine sandy loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; common very fine and fine roots and few medium and coarse roots; few very fine discontinuous pores; 25 percent rounded pebbles; slightly acid; clear wavy boundary.

C1-16 to 25 inches; yellowish brown (10YR 5/4) gravelly fine sandy loam, light yellowish brown (10YR 6/4) dry; massive; soft, friable, slightly sticky and nonplastic; weakly smeary; few very fine, fine, medium, and coarse roots; common very fine discontinuous pores; 30 percent rounded pebbles; slightly acid; abrupt wavy boundary.

IIC2-25 to 60 inches; very dark grayish brown (2.5Y 3/2) extremely gravelly coarse sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; few fine and medium roots to a depth of about 30 inches; 80 percent rounded pebbles; slightly acid.

The solum is 15 to 30 inches thick. The mean annual soil temperature at a depth of 20 inches is 47 to 50

degrees F. The upper part of the 10- to 40-inch control section is 15 to 35 percent rock fragments, and the lower part is 35 to 60 percent rock fragments.

The A horizon has value of 2 or 3 when moist and 3 or 4 when dry, and it has chroma of 1 or 2 when moist or dry.

The B horizon has hue of 5YR, 7.5YR, or 10YR. It is gravelly sandy loam, gravelly fine sandy loam, or gravelly loam.

The IIC horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6 when moist and 3 to 7 when dry, and chroma of 2 to 6 when moist or dry. It is very gravelly loamy coarse sand, extremely gravelly coarse sand, very gravelly sand, or extremely gravelly sand.

formation of the soils

Soil is a result of the interaction of soil-forming processes on material deposited by geologic agents (15). The properties of the soil at any given place are determined by five factors: (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material accumulated and existed, (3) the living organisms on and in the soil, (4) topography, and (5) the length of time the forces of soil formation have acted on the soil material. These factors, as they occur in the survey area, are described in this section.

parent material

Parent material is the unconsolidated and mostly chemically weathered mineral or organic matter from which soil is formed. Most of the soils in Snohomish County Area formed in deposits of glacial drift laid down during the Vashon Period of the Fraser Glaciation, late in the Pleistocene (11). The major kinds of material deposited by the glacier are till, outwash, and some material mixed with volcanic ash.

Vashon Till is of very dense, consolidated lodgment till with a mantle of ablation till. The Alderwood soil is an example of the soils that formed in this material. Very poorly drained, depressional areas occur in the glacial till, and organic material from surrounding wet, mineral soils accumulates in these areas. The Mukilteo and Orcas soils are examples of these organic soils.

As the Vashon Glacier melted, large quantities of melt water sorted material in its path, leaving very gravelly and sandy sediment. The Indianola, Custer, Everett, and Lynnwood soils are examples of soils that formed in this glacial outwash. Some of the melt water was dammed, resulting in the deposition of lacustrine material that extends from the valleys to the foot slopes of the mountains. The Bellingham, Kitsap, Pastik, and Rober soils formed in this material.

Alluvium, mostly silty alluvium mixed with volcanic ash, accumulated in the major valleys in postglacial times. The Puget, Puyallup, Snohomish, and Sultan soils are examples of soils that formed in these accumulations of alluvium.

On the mountainsides and plateaus in the area are colluvium and residuum derived from andesite and basalt and influenced by a thin mantle of volcanic ash. The Hartnit and Olomount soils are examples of moderately deep soils that formed in colluvium and residuum.

topography

Topography or relief affects soil formation by influencing the drainage pattern and runoff of the soil surface and the internal drainage in the soil profile.

Level or nearly level soils receive more effective precipitation than steeper soils. In contrast to the steeper soils, therefore, the more nearly level soils are leached of more minerals and organic matter and commonly are leached and weathered to a greater depth. They show more development in the profile, particularly a thicker, darker, and redder B horizon.

Topography also influences soil formation and soil characteristics by concentrating water in depressional areas and at the toe of slopes. Most of the poorly drained upland soils, including the Bellingham, McKenna, and Mukilteo soils, are in this type of topographic position.

Aspect can also influence soil characteristics. Soils on steep, north-facing slopes generally receive more effective precipitation than soils on south-facing slopes. This is because less solar energy reaches the north-facing slopes, which reduces the evaporation of water from the soil.

living organisms

Plants, micro-organisms, earthworms, insects, fungi, and other forms of life are active in soil-forming processes. They contribute organic matter and nitrogen to the soil material, help to decompose plant residue, and affect soil reaction.

Plant life in the survey area probably has had a greater effect on soil formation than have animals. Some soils, such as the Hartnit and Lynnwood soils, developed predominantly under conifers and typically have a thin, dark-colored surface layer and a distinct subsurface layer. Other soils, such as the Norma and McKenna soils, formed under mixed stands of trees and commonly have a darker and thicker surface layer and do not have a subsurface layer. Soils that formed under sedges, rushes, and grasses in open areas of valley bottoms have a thick, very dark brown or black surface layer. The Snohomish soils are an example.

Earthworms, insects, and micro-organisms help to convert organic compounds and other soil elements into forms suitable for plant use, and they aid in soil aeration. Burrowing animals, such as moles and mice, add organic

material to the soil and bring nutrients from the subsoil to the surface; the nutrients replace those that have been leached from the surface layer or have been used by the plants. These animals also help improve soil drainage and aeration.

climate

Precipitation and temperature are the main climatic factors that have influenced soil formation in the survey area. Three distinct climatic zones are in the area. The first is the western part of the area, which ranges from near sea level to an elevation of about 800 feet. The average annual precipitation in this zone is 30 to 60 inches, the average frost-free period is 160 to 210 days, and the mean annual air temperature is about 50 degrees F. The second is in the middle part of the area, which ranges from 800 to 1,800 feet in elevation. The average annual precipitation in this part is 60 to 80 inches, the average frost-free period is 140 to 160 days, and the mean annual air temperature is about 45 degrees F. The third is in the eastern part of the area, which has an elevation of more than 1,800 feet. The average annual precipitation in this part is 80 inches or more, the average frost-free period is 90 to 140 days, and the mean annual air temperature is about 42 degrees F.

Soils on uplands in the western part of the area have a weakly developed subsurface layer, and soils in the eastern part have a distinct subsurface layer. The Alderwood soils in the western part and the Potchub soils in the eastern part are examples. The Olomount, Oso, and Verlot soils, on uplands in the eastern part of the survey area, are more acid and are leached of bases more than the Alderwood, Cathcart, and Ogarty soils in the western part. Also, the Everett and Tokul soils in the western part have a warmer temperature and a thinner organic surface layer than the Potchub and Verlot soils.

Additional information on climate of the area is given under "Climate" in the section "General nature of the survey area."

time

Time is necessary for the formation of soils and their horizons. Most of the soils in the survey area do not have a strongly expressed subsoil. Old soils commonly have more strongly expressed horizons than young soils.

In this area soil-forming processes have been acting on parent material since the glaciation, or about 12,000 years. Alluvium has periodically accumulated in the stream valleys, and soils such as the Norma, Pilchuck, and Puyallup soils formed. Soils that formed on the uplands have a dark-colored surface layer and subsoil and are redder in color than the parent material. Everett and Winston soils are examples.

The texture of parent material is an important factor in soil formation. Soils that form in sandy material develop structure more slowly than do soils that form in clayey material.

references

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. In 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Anderson, A. C. 1947. Soil survey of Snohomish County, Washington. U.S. Dep. Agric. 76 pp., illus.

(4) Barnes, George H. 1962. Yield of even-aged stands of western hemlock. U.S. Dept. Agric. Techn. Bull. 1273.

(5) Bassett, Patricia M. and Grover A. Choate. 1974. Timber resource statistics for Washington. U.S. Dep. Agric., Forest Serv. Res. Bull. PNW-53, 33 pp.

(6) Brady, Roy C. 1978. Forest products directory for the state of Washington. State of Wash. Dep. Nat. Resour., 164 pp.

(7) Chambers, Charles J. 1974. Empirical yield tables for predominantly alder stands in Western Washington. State of Wash. Dep. Nat. Resour. Rep. No. 31, 70 pp.

(8) Chambers, Charles J. and Franklin M. Wilson. 1972. Empirical yield tables for the Douglas-fir zone. State of Wash. Dep. Nat. Resour. Rep. No. 20R, 16 pp.

(9) Chambers, Charles J. and Franklin M. Wilson. 1978. Empirical yield tables for the western hemlock zone. State of Wash. Dep. Nat. Resour. Rep. No. 22R, 12 PP.

(10) Cline, Marlin G. 1949. Basic principles of soil classification. Soil Sci. 67: 81-91.

(11) Crandell, Dwight R., P. R. Mullineaux, and H. H. Waldron. 1965. Age and origin of the Puget Sound Trough in Western Washington. U.S. Geol. Surv. Prof. Pap.

(12) King, James E. 1966. Site index curves for Douglas-fir in the Pacific Northwest. Forestry Pap. No. 8., Weyerhauser Co., 49 pp., illus.

(13) McArdle, R. E., W. H. Meyer, and D. Bruce. 1961. The yield of Douglas-fir in the Pacific Northwest. U.S. Dep. Agric. Tech. Bull. 201, 74 pp., illus.

(14) Portland Cement Association. 1962. PCA soil primer. 52 pp., illus.

(15) Simonson, Roy W. 1959. Outline of a generalized theory of soil genesis. Soil Sci. Soc. Am. Proc. 23: 152-156, illus.

(16) Snohomish County. 1971. General land use plan, technical supplement. Land Use Manual Tech. Rep. No. 3, 24 pp., illus.

(17) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(18) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(19) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(20) Washington Conservation Needs Committee. 1970. Washington soil and water conservation needs inventory. U.S. Dep. Agric., Soil Conserv. Serv., 249 pp., illus.

(21) Wiley, Kenneth. 1978. Site index tables for western hemlock in the Pacific Northwest. Forestry Pap. No. 17., Weyerhaeuser Co., 22 pp.

(22) Worthington, Norman P., Floyd A. Johnson, George R. Staebler, and William J. Lloyd. 1960. Normal yield tables for red alder. U.S. Dep. Agric. Res. Pap. 36, 29 pp.

glossary

ABC soil. A soil having an A, a B, and a C horizon.

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Cable yarding. A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a fragment.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

CMAI (culmination of the mean annual increment). The average annual increase per acre in the volume

of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are-

Loose. -Noncoherent when dry or moist; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.-When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented-Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Culmination of the mean annual increment. See CMAI.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.-Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained-Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained-Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.-Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.-Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious
layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.-Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage

results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.-Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Duff. A term used to identify a generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess alkali (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most. plants.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fill slope. A sloping surface consisting of excavated soil material from a road cut. It is commonly on the downhill side of the road.

Fine textured soil. Sandy clay, silty clay, and clay.

Firebreak. Areas cleared of flammable material to stop or help to control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of men and equipment in fire fighting. Designated roads also serve as firebreaks.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:

O horizon.-An organic layer of fresh and decaying plant residue at the surface of a mineral soil. *A horizon.*-*The* mineral horizon at or near the surface in which an. accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.-The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of *a* C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are-

Border.-Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.-Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding. -Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.-Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).-Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow-Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler-Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.-Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.-Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance-few, *common,* and *many, size-fine, medium,* and *coarse;* and contrast-faint, *distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables-hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting (in tables). Pits caused by melting ground ice. They form on the soil after plant cover is removed.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size

of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Post and piling outlets. A market location where posts and pilings are bought, processed, and sold.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as-

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Salty water (in tables.) Water that is too salty for consumption by livestock.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Site class. A grouping of site indexes into 5 to 7 production capability levels. Each level can be represented by a site curve.

Site curve (50-year). A set of related curves on a graph that shows the average height of dominant trees for a range of ages on soils that differ in productivity. Each level is represented by a curve. The bases of the curves are the height of dominant trees that are 50 years old or are 50 years old at breast height.

Site curve (100-year). A set of related curves on a graph that shows the average height of dominant and codominant trees for a range of ages on soils that differ in productivity. Each level is represented by a curve. The bases of the curves are the height of dominant and codominant trees that are 100 years old or are 100 years old at breast height.

Site index. The height that dominant or dominant and codominant trees reach at 50 years total age or breast-height age, or 100 years total age or breast-height age. With this index and the age of the stand of trees, yield can be determined by using the appropriate yield table.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60, centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are *platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils* are either *single grained (each grain by itself, as in dune sand) or massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine.

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Tuff. *A compacted deposit that is 50 percent or more* volcanic ash and dust.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Water bars. Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow. The action of uprooting and tipping over trees by the wind.