Foreword

This soil survey contains information that can be used in land-planning programs in Skagit 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 ensure 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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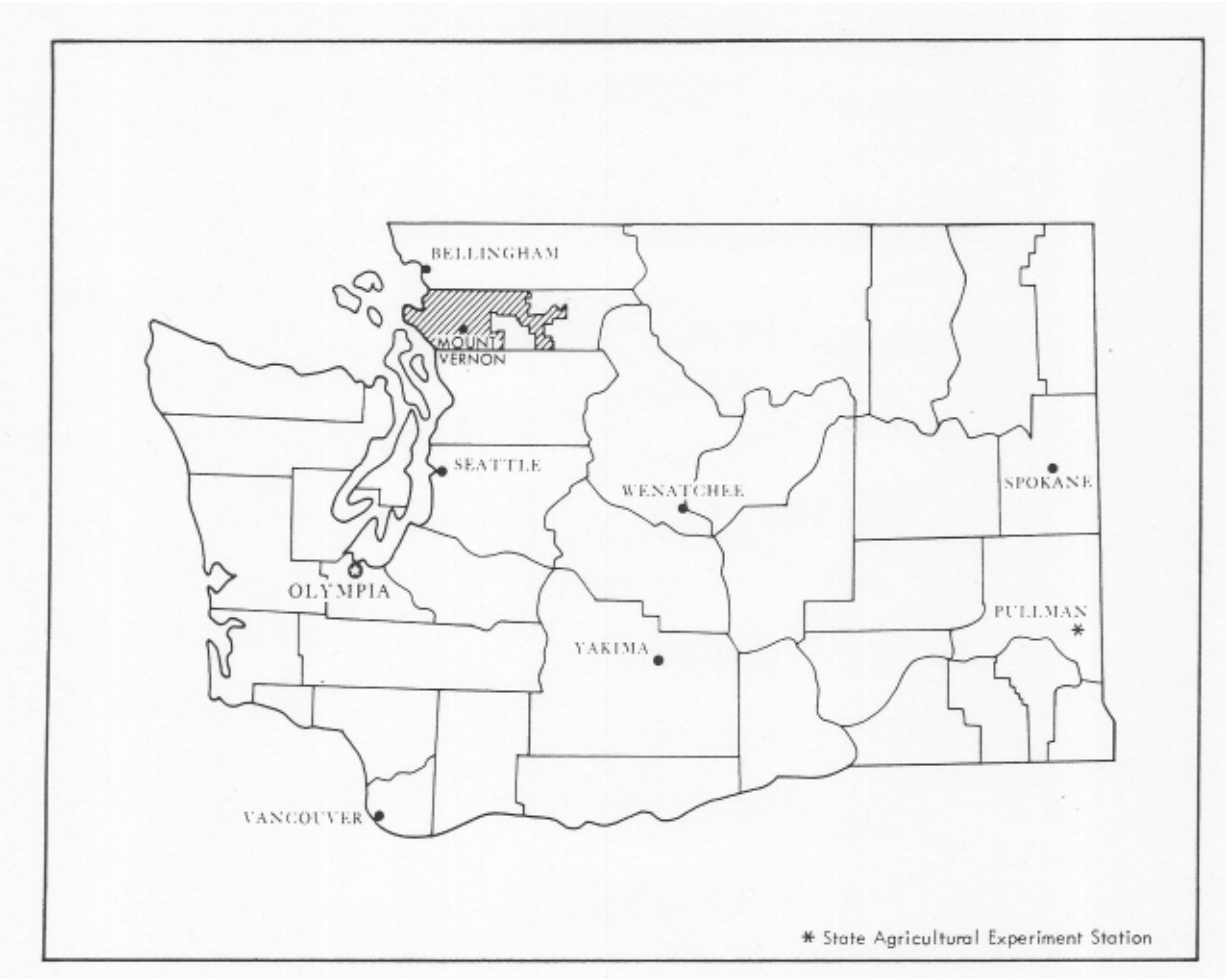

Location of Skagit County Area in Washington.

Soil Survey of
Skagit County Area, Washington

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cooperation with
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Agriculture Research Center

SKAGIT COUNTY AREA is in the northwestern part of Washington. It has a total area of 598,494 acres, or 935 square miles. The remaining 909 square miles of Skagit County, which is not included in the survey area, is in Mount Baker National Forest and parts of the North Cascades National Park and Glacier Peak Wilderness Area. Mount Vernon, the county seat of Skagit County, is in the west-central part of the survey area. The population of the county in 1979 was about 60,000 (7).

The survey area is characterized by mountainous topography in the central and eastern parts and by level flood plains and rolling uplands in the western part. The Skagit River and its tributaries drain the mountainous areas from east to west. Elevation in the survey area ranges from sea level to about 4,500 feet.

Farming and forest products are the main sources of income in Skagit County. The mild marine climate and highly productive soils in the western part of the county contribute to large crop yields and a productive dairy industry. The mountain areas that receive greater rainfall produce timber products for the lumber, pulp, and paper industries.

Soil scientists determined that there are 84 soil series and soil variants in the survey area. The soils range widely in texture, natural drainage, and other characteristics. Those in the western part of the survey area are mostly level and moderately well drained to poorly drained. Those in the central and eastern parts are steep and very steep and are moderately well drained to well drained. Wetness and flooding are the main limitations for most of the soils in the western part of the area, and steepness of slope is the main limitation in the central and eastern parts.

An older survey, "Soil Survey of Skagit County, Washington," was published in 1960 (15). This earlier survey covers a part of the present survey. The present survey, however, updates the earlier survey and provides additional information.

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

General Nature of the Survey Area

This section briefly discusses the history and development; physiography, relief, and drainage; and climate of the survey area.

History and Development

The first settlers in the survey area built their log cabins on Fidalgo Island in 1856-59. In 1867 the first

trading post in the area was established at the present site of the city of La Conner. In 1884 Skagit County was established and named after the Skagit River and Skagit Indian Tribe who lived along its banks.

Loggers and homesteaders came into the survey area during the 1880's and 1890's. Economical steamship transportation was established in 1874 and railroad transportation in 1891, which made Mount Vernon the center for agricultural and industrial development. The Skagit River flood plain and delta along with adjacent upland areas were cleared during this time. Oats and hay were grown on the flood plain to feed the horses working in the logging camps. As the easily accessible forests were cleared, the logging industry declined and the dairy industry and farming began to thrive on the fertile bottom lands of the county. Small fruit and orchard crop production was profitable for the first homesteaders in the upland areas.

Other industries that developed after the turn of the century were steel production in Sedro Woolley, various mining enterprises in the mountainous areas, fishing, and food processing. In more recent years oil refineries near Anacortes and tourism have made a significant contribution to the economy of the area.

Physiography, Relief, and Drainage

The survey area can be divided into four broad physiographic areas: (1) the low precipitation uplands, which include several islands; (2) the flood plain-delta; (3) the high precipitation uplands; and (4) the mountains.

The low precipitation uplands area, which consists of general soil map unit 7, is in the far-western part of the survey area. It includes islands in Puget Sound. Elevation ranges from sea level to 1,500 feet. The climate is mild, and the average annual precipitation ranges from 18 to 40 inches. This area is characterized by gently sloping to very steep, glaciated remnant lakebed terraces. Parts of this area have been influenced by the geology of the bedrock. Some of the typical kinds of rock are granite on Mount Erie, argillite on the central part of Fidalgo Island, and serpentine on Cypress Island. A unique feature of this area is that it does not have any major natural drainageways. The land adjacent to Puget Sound is allocated to uses associated with recreation, such as is needed to support boating, fishing, and camping.

The flood plain-delta area, which consists of general soil map units 1 and 2, extends from the far-eastern part of the survey area following the Skagit River and its tributaries to its mouth in Puget Sound and from the northwestern part of the survey area following the Samish River to its mouth in Puget Sound. Elevation in this area ranges from sea level to 500 feet. The area is used for farming and as homesites. The climate is mild, and the annual precipitation ranges from 25 inches in the west to 80 inches in the east. Typically, this area is level to nearly level alluvial bottom land. The Skagit and Samish Rivers have had a long history of flooding. The flood plain area on the lower reaches of the Skagit River, from just west of Sedro Woolley to Puget Sound, is protected from flooding by dikes and levees. These dikes and levees protect the residential areas and cropland along this part of the Skagit River from floods that occur once every 14 years. The flood plain area along the lower reaches of the Samish River, below Thomas Creek, is flooded almost every year.

The high precipitation uplands area, which consists of general soil map units 3, 4, 5, and 6, extends from the central part of the survey area to its far-eastern part. Elevation ranges from 100 to 1,500 feet. This area is level to extremely steep glaciated uplands, glaciolacustrine terraces, and glacial outwash terraces. The annual precipitation is 32 to 75 inches. The climate is mild and is characterized by wet winters and warm, dry summers. This area is drained by many small creeks that flow into the Skagit and Samish Rivers. Parts of this area have been influenced by the geology of the bedrock. Typical kinds of rock are phyllite and sandstone. This area is used as homesites, small farms, and woodland.

The mountains area, which consists of general soil map units 8 and 9, is in the central and eastern parts of the survey area. Elevation dominantly ranges from 800 to 4,200 feet. The annual precipitation ranges from 60 inches to more than 100 inches. Summers are mild and dry, and winters are cold and wet. Much of the precipitation falls as snow. Bedrock is near the surface in much of the area. Typical kinds of rock are phyllite, serpentine, dunite, and granite. Many of the small streams that drain this area flow into the Skagit, Samish, Nooksack, and Stilliguamish Rivers. This area is used mostly as woodland and recreation areas.

Climate

By the National Climatic Data Center, Asheville, North Carolina.

The climate of the survey 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 higher elevations. In summer rainfall is extremely light, so crops need irrigation to grow actively during this

period. Several weeks often pass without precipitation. Rains are frequent during the rest of the year, especially late in fall and in winter.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Concrete in the period 1951-78 and at Mount Vernon in the period 1956-78. 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 temperature at Concrete and Mount Vernon is 38 and 40 degrees F, respectively. The average daily minimum temperature is 33 degrees at Concrete and 34 degrees at Mount Vernon. The lowest temperature on record, which occurred on January 26, 1957, at Mount Vernon, is -4 degrees. In summer, the average temperature is 63 degrees at Concrete and 61 degrees at Mount Vernon. The average daily maximum temperature is about 73 degrees. The highest recorded temperature, which occurred at Concrete on July 12, 1951, is 102 degrees.

Growing degree days are shown in table 1. They 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). 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 70 inches at Concrete and 32 inches at Mount Vernon. Of this, 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 4.25 inches at Concrete on December 2, 1977. Thunderstorms occur on about 7 days each year, and most occur in summer.

The average seasonal snowfall is 30 inches at Concrete and 7 inches at Mount Vernon. The greatest snow depth at any one time during the period of record was 44 inches. On an average, 7 days at Concrete and 4 days at Mount Vernon have at least 1 inch of snow on the ground. 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 80 percent. The sun shines 65 percent of the time in summer and 25 percent in winter. The prevailing wind is from the southwest. Average windspeed is highest, 9 miles per hour, in winter.

In most winters one or two storms over the entire survey 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

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind or segment of the landscape. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Individual soils on the landscape commonly merge gradually onto one another as their characteristics gradually change. To construct an accurate map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted color, texture, size, and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and

other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While the soil survey was in progress, samples of some of the soils in the area were collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses and under different levels of management. Some interpretations were modified to fit local conditions, and some new interpretations were developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

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 or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The soils or miscellaneous areas 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 or miscellaneous areas can be identified on the map. Likewise, areas that 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 general map units in this survey have been grouped into general kinds of landscape for broad interpretive purposes. Each of the broad groups and the map units in each group are described in the following pages.

Map Unit Descriptions

Soils on Flood Plains, Low Terraces, and Deltas

This group consists of two map units. It makes up about 25 percent of the survey area.

1. Skagit-Sumas-Field

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

This map unit is in the western part of the survey area, on the Skagit Flats. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly hardwoods and conifers. Elevation is sea level to 50 feet. The average annual precipitation is 32 to 40 inches, the average annual air temperature is about 50 or 51 degrees F, and the average frost-free season is 160 to 220 days.

This unit makes up about 16 percent of the survey area. It is about 26 percent Skagit soils, 15 percent Sumas soils, and 14 percent Field soils. The remaining 45 percent is components of minor extent.

Skagit soils are very deep and naturally poorly drained, but they have been artificially drained and protected in most areas. Undrained areas of Skagit soils are high in salt content. These soils formed in recent alluvium and volcanic ash. The surface layer is silt loam about 12 inches thick. The upper 38 inches of the underlying material is silt loam and silty clay loam, and the lower part to a depth of 60 inches or more is very fine sandy loam.

Sumas soils are very deep and naturally poorly drained, but they have been artificially drained and protected in most areas. These soils formed in alluvium. The surface layer, to a depth of about 13 inches, is silt loam over silty clay loam. The upper 17 inches of the underlying material is silt loam and loamy sand, and the lower part to a depth of 60 inches or more is coarse sand.

Field soils are very deep and moderately well drained. They formed in recent alluvium and volcanic ash. The surface layer and upper part of the underlying material are silt loam about 21 inches thick. The lower part of the underlying material to a depth of 60 inches or more is stratified fine sand to very fine sandy loam. These soils are frequently flooded.

Of minor extent in this unit are very poorly drained Tacoma soils that are on tidal flats and are salt influenced unless protected and drained; Briscot, Mt. Vernon, Mukilteo Variant, Nookachamps, excessively drained Pilchuck Variant, and Snohomish soils on flood plains; and Samish and Sedrowoolley soils on low terraces.

This unit is used mainly as cropland, hayland, and pastureland. It is also used as homesites and urban and industrial areas. Some areas are used for recreation and wildlife habitat.

This unit is poorly suited to homesite, urban, and industrial development. The main limitations are the hazard of flooding and the seasonal high water table.

2. Larush-Pilchuck

Very deep, well drained and excessively drained, level to gently sloping soils; on flood plains and low terraces

This map unit is in the central and eastern parts of the survey area. Slope is 0 to 5 percent. Elevation is 20 to 500 feet. The average annual precipitation is 55 to 70 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 160 to 220 days.

This unit makes up about 9 percent of the survey area. It is about 17 percent Larush soils and 14 percent Pilchuck soils. The remaining 69 percent is components of minor extent.

Larush soils are on occasionally flooded flood plains and low terraces along the Skagit and Sauk Rivers. The soils are very deep and well drained. They formed in alluvium. The surface is covered with a mat of needles, leaves, and twigs. The surface layer is fine sandy loam or silt loam about 15 inches thick. The subsoil is very fine sandy loam and silt loam about 19 inches thick. The substratum to a depth of 60 inches or more is fine sand and silt loam.

Pilchuck soils are on frequently flooded flood plains along the Skagit and Sauk Rivers. The soils are very deep and excessively drained. They formed in alluvium. The surface layer is loamy sand about 3 inches thick. The upper 40 inches of the underlying material is fine sand and sand, and the lower part to a depth of 60 inches or more is gravelly sand.

Of minor extent in this unit are Barneston, Giles, Gilligan, and Indianola soils on remnant glacial outwash terraces; Wickersham and Wiseman soils on alluvial fans; and Giles Variant, Minkler, Nargar, and Sauk soils on low alluvial terraces.

This unit is used as cropland, pastureland, woodland, and homesites. It is poorly suited to homesite development. The main limitation is the hazard of flooding.

Soils on Uplands and Mountains

This group consists of seven map units. It makes up 75 percent of the survey area.

3. Barneston-Dystric Xerorthents-Indianola

Very deep, somewhat excessively drained and excessively drained, level to very steep soils; on terraces and terrace escarpments

This map unit is in the central and eastern parts of the survey area, along the major drainageways of the Skagit River. Slope is 0 to 80 percent. Elevation is 200 to 1,200 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 220 days.

This unit makes up about 9 percent of the survey area. It is about 44 percent Barneston soils, 19 percent Dystric Xerorthents, and 6 percent Indianola soils. The remaining 31 percent is components of minor extent.

Barneston soils are on glacial outwash terraces and terrace escarpments. The soils are very deep and somewhat excessively drained. They formed in loess and volcanic ash underlain by glacial outwash. The surface is covered with a mat of needles and twigs. The surface layer and subsoil are gravelly loam, very gravelly sandy loam, or very cobbly sandy loam about 20 inches thick. The substratum to a depth of 60 inches or more is very cobbly loamy sand, very gravelly loamy coarse sand, or extremely gravelly sand.

The Dystric Xerorthents are on steep to extremely steep terrace escarpments. The soils are very deep and excessively drained. They formed in glacial outwash. The surface is covered with a mat of needles, leaves, and twigs. The surface layer is gravelly sandy loam about 4 inches thick. The subsoil is gravelly loamy sand about 31 inches thick. The substratum to a depth of 60 inches or more is stratified very gravelly sand and gravelly sand.

The Indianola soils are on terraces. The soils are very deep and somewhat excessively drained. They formed in sandy glacial outwash. The surface is covered with a mat of needles, leaves, and twigs. The surface layer is dark brown sandy loam about 6 inches thick. The upper 25 inches of the subsoil is loamy sand. The lower 24 inches of the subsoil and the substratum to a depth of 60 inches or more are sand.

Of minor extent in this unit are Greenwater soils and well drained Gilligan, Giles, Nargar, and Winston soils on terraces; Kline and Wiseman soils on alluvial fans; well drained Wickersham soils on alluvial fans and terraces; and poorly drained Norma soils in drainageways and depressional areas.

This unit is used as woodland and homesites. If the unit is used for homesite development, the main

limitations are steepness of slope and the risk of seepage from onsite sewage disposal systems.

4. Tokul-Skipopa-Dystric Xerochrepts

Moderately deep to very deep, somewhat poorly drained to well drained, level to extremely steep soils; on terraces, hills, and escarpments

This map unit is in the northwestern and southwestern parts of the survey area. It is mainly on glaciated uplands and lakebed terraces. This unit is characterized by a very complex, irregular, glaciated topography. Slope is 0 to 90 percent. Elevation is sea level to 1,100 feet. The average annual precipitation is 45 to 55 inches, the average annual air temperature is 50 or 51 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 46 percent Tokul soils, 30 percent Skipopa soils, and 20 percent Dystric Xerochrepts. The remaining 4 percent is components of minor extent.

Tokul soils are on glacially modified hills. The soils are moderately deep and moderately well drained. They formed in volcanic ash and loess underlain by glacial till. The surface is covered with a mat of needles, leaves, and twigs. The surface layer and subsoil are gravelly loam about 34 inches thick. The substratum is gravelly sandy loam about 5 inches thick over silica-cemented glacial till. Depth to silica-cemented glacial till ranges from 20 to 40 inches.

Skipopa soils are on lakebed terraces. The soils are very deep and somewhat poorly drained. They formed in a mantle of loess and volcanic ash underlain by glaciolacustrine sediment. The surface is covered with a mat of leaves and twigs. The surface layer and subsoil are silt loam about 16 inches thick. The substratum to a depth of 60 inches or more is silty clay.

Dystric Xerochrepts are on steep to extremely steep escarpments. The soils are moderately deep to very deep and are well drained. They formed in glacial till and colluvium. The surface is covered with a mat of needles, leaves, and twigs. The surface layer is gravelly loam about 4 inches thick. The subsoil, to a depth of about 40 inches, is very gravelly loam and very gravelly sandy loam. The substratum to a depth of 60 inches or more is very gravelly sandy loam. Depth to bedrock or dense glacial till ranges from 20 inches to more than 60 inches.

Of minor extent in this unit are poorly drained Bellingham soils and very poorly drained Mukilteo soils in depressional areas, somewhat excessively drained Barneston soils on terraces, Hoogdal soils on terraces and terrace escarpments, Bow soils on terraces and plains, Cathcart soils on plains and foothills, Vanzandt soils on plains and low mountainsides, Chuckanut soils on hills, and Heisler soils on mountainsides.

This unit is used as woodland, pastureland, hayland, and homesites.

If this unit is used for homesite development, the main limitations are steepness of slope, a seasonal high water table, and very slow permeability.

5. Vanzandt-Montborne-Squires

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

This map unit is in the central and eastern parts of the survey area. Slope is 0 to 65 percent. Elevation is 250 to 1,500 feet. The average annual precipitation is 55 to 75 inches, the average annual air temperature is 43 to 50 degrees F, and the average frost-free season is 120 to 200 days.

This unit makes up about 21 percent of the survey area. It is about 24 percent Vanzandt soils, 12 percent Montborne soils, and 5 percent Squires soils. The remaining 59 percent is components of minor extent.

Vanzandt soils are on glacially modified plains and low mountainsides. The soils are moderately deep and moderately well drained. They formed in volcanic ash and glacial till. The surface is covered with a mat of needles, leaves, and twigs. The surface layer and subsoil are very gravelly loam about 25 inches thick. The substratum is very gravelly sandy loam about 11 inches thick over dense glacial till. Depth to dense glacial till ranges from 20 to 40 inches.

Montborne soils are on glaciated mountainsides. The soils are moderately deep and moderately well drained. They formed in glacial till and volcanic ash. The surface is covered with a mat of needles, leaves, and twigs. The surface layer is very gravelly loam about 6 inches thick. The subsoil and substratum are extremely gravelly loam about 26 inches thick over dense glacial till. Depth to dense glacial till ranges from 20 to 40 inches.

Squires soils are on glacially modified mountainsides. The soils are moderately deep and well drained. They formed in colluvium derived from phyllite, volcanic ash, and glacial till. The surface is covered with a mat of needles, leaves, and twigs. The surface layer and subsoil are very gravelly silt loam about 17 inches thick. The substratum is very gravelly loam 15 inches thick over phyllite. Depth to phyllite ranges from 20 to 40 inches.

Of minor extent in this unit are somewhat excessively drained Barneston soils on terraces, Skiyou soils on hills. Dystric Xerochrepts on escarpments and mountainsides, and Heisler and Rinker soils on mountainsides.

This unit is used as woodland. The main limitations are steepness of slope and seasonal soil wetness.

6. Chuckanut-Cathcart

Deep and very deep, well drained, moderately sloping to very steep soils, on plains, foothills, hills, and mountainsides

This map unit is in the southwestern part of the survey area. Slope is 8 to 65 percent. Elevation is 300 to 1,500 feet. The average annual precipitation is 40 to 45 inches, the average annual air temperature is 48 or 49 degrees F, and the average frost-free season is 160 to 200 days.

This unit makes up about 3 percent of the survey area. It is about 50 percent Chuckanut soils and 35 percent Cathcart soils. The remaining 15 percent is components of minor extent.

Chuckanut soils are on hills and mountainsides. The soils are deep and well drained. They formed in volcanic ash and colluvium derived from sandstone and glacial till. The surface is covered with a mat of needles, leaves, and twigs. The surface layer and upper part of the subsoil are gravelly loam about 15 inches thick. The lower part of the subsoil is gravelly sandy loam about 20 inches thick. The substratum is gravelly loam 14 inches thick over sandstone. Depth to sandstone ranges from 40 to 60 inches.

Cathcart soils are on glaciated plains, foothills, and mountainsides. The soils are very deep and well drained. They formed in volcanic ash, glacial till, and sandstone. The surface is covered with a mat of needles, leaves, and twigs. The surface layer and subsoil are loam about 40 inches thick. The substratum to a depth of 60 inches or more is gravelly sandy loam.

Of minor extent in this unit are somewhat excessively drained Barneston soils on terraces, moderately well drained Tokul soils on hills, and Squires soils on mountainsides.

Most areas of this unit are used as woodland. A few areas are used as homesites or pastureland. If this unit is used for homesite development, the main limitation is steepness of slope.

7. Bow-Coveland-Swinomish

Moderately deep and very deep, somewhat poorly drained and moderately well drained, level to steep soils; on terraces and hills

This map unit is in the western part of the survey area. The unit is characterized by a terracelike appearance. Slope is 0 to 30 percent. Elevation is sea level to 1,500 feet. The average annual precipitation is 20 to 40 inches, the average annual air temperature is 50 degrees F, and the average frost-free season is 160 to 220 days.

This unit makes up about 5 percent of the survey area. It is about 44 percent Bow soils, 21 percent Coveland soils, and 20 percent Swinomish soils. The remaining 15 percent is components of minor extent.

Bow soils are on glacial remnant terraces. The soils are very deep and somewhat poorly drained. They formed in glacial drift over glaciolacustrine sediment with a mantle of volcanic ash. The surface is covered with a mat of leaves and twigs. The surface layer and upper part of the subsoil are gravelly loam about 8 inches thick. The lower part of the subsoil to a depth of 60 inches or more is clay loam over silty clay.

Coveland soils are in swales on glaciated hills. The soils are very deep and somewhat poorly drained. They formed in glaciolacustrine sediment. The surface is covered with a mat of needles, leaves, and twigs. The surface layer is gravelly loam over very gravelly sandy loam about 14 inches thick. The subsoil and substratum to a depth of 60 inches or more are silty clay.

Swinomish soils are on glaciated hills. The soils are moderately deep and moderately well drained. They formed in glacial till with an admixture of loess and volcanic ash. The surface is covered with a mat of needles, leaves, and twigs. The surface layer and upper part of the subsoil are gravelly loam about 20 inches thick. The lower part of the subsoil and the substratum are very gravelly fine sandy loam over very gravelly sandy loam about 11 inches thick over dense glacial till. Depth to dense glacial till ranges from 25 to 40 inches.

Of minor extent in this unit are Catla, Clallam, Fidalgo, and Laconner soils on hills, excessively drained Keystone soils on hills, and well drained Whistle soils on colluvial slopes.

This unit is used as woodland, hayland, pastureland, and homesites. If the unit is used for homesite development, the main limitation is a perched seasonal high water table.

8. Skykomish-Jug-Saxon

Very deep, moderately well drained and somewhat excessively drained, level to very steep soils; on terraces, terrace escarpments, and hills

This map unit is in the south-central and north-central parts of the survey area. Slope is 0 to 65 percent. Elevation is 800 to 2,000 feet. The average annual precipitation is 70 to 75 inches, the average annual air temperature is 43 or 44 degrees F, and the average frost-free season is 100 to 125 days.

This unit makes up about 6 percent of the survey area. It is about 14 percent Skykomish soils, 11 percent Jug soils, and 8 percent Saxon soils. The remaining 67 percent is components of minor extent.

Skykomish soils are on terraces, terrace escarpments, and hills. The soils are very deep and somewhat excessively drained. They formed in volcanic ash and glacial outwash. The surface is covered with a mat of needles, leaves, and twigs. The surface layer and subsoil are very gravelly sandy loam about 17 inches thick. The substratum to a depth of 60 inches or more is very gravelly loamy sand.

Jug soils are on terraces. The soils are very deep and somewhat excessively drained. They formed in volcanic ash and glacial outwash. The surface is covered with a mat of needles, leaves, and twigs. The surface layer is very gravelly loam about 7 inches thick. The subsoil is extremely cobbly sandy loam over extremely cobbly loamy sand about 34 inches thick. The substratum to a depth of 60 inches or more is extremely cobbly sand.

Saxon soils are on terraces and hills. The soils are very deep and moderately well drained. They formed in volcanic ash underlain by glaciolacustrine sediment. The surface is covered with a mat of needles. leaves. and twigs. The surface layer, subsoil, and upper part of the substratum are silt loam about 21 inches thick. The lower part of the substratum to a depth of 60 inches or more is silty clay loam.

Of minor extent in this unit are Cupples soils on hills and excessively drained Dystric Xerorthents on terrace escarpments.

This unit is used as woodland. The main limitations are steepness of slope and seasonal soil wetness.

9. Wollard-Kindy-Diobsud

Moderately deep, moderately well drained, gently sloping to very steep soils: on mountains

This map unit is in the central and eastern parts of the survey area. Slope is 3 to 65 percent. Elevation is mainly 1,800 to 4,200 feet. The average annual precipitation is 80 to 90 inches, the average annual air temperature is 38 to 43 degrees F, and the average frost-free season is 90 to 120 days.

This unit makes up about 25 percent of the survey area. It is about 17 percent Wollard soils, 15 percent Kindy soils, and 9 percent Diobsud soils. The remaining 59 percent is components of minor extent.

Wollard soils are on glacially modified mountainsides. The soils are moderately deep and moderately well drained. They formed in volcanic ash and glacial till derived dominantly from phyllite. The surface is covered with a mat of needles, leaves, and twigs. The surface layer and upper part of the subsoil are gravelly silt loam about 8 inches thick. The lower part of the subsoil and the substratum are gravelly loam 24 inches thick over dense glacial till. Depth to dense glacial till ranges from 20 to 40 inches.

Kindy soils are on glacially modified mountainsides. The soils are moderately deep and moderately well drained. They formed in volcanic ash, loess, and glacial till. The surface is covered with a mat of leaves, needles, and twigs. The surface layer is gravelly silt loam about 4 inches thick. The subsoil is very gravelly silt loam 15 inches thick. The substratum is very gravelly loam 7 inches thick over dense glacial till. Depth to dense glacial till ranges from 20 to 40 inches.

Diobsud soils are on glacially modified mountainsides. The soils are moderately deep and moderately well drained. They formed in volcanic ash and glacial till derived dominantly from phyllite. The surface is covered with a mat of needles, leaves, and twigs. The surface layer is gravelly silt loam about 4 inches thick. The subsoil and substratum to a depth of 28 inches are gravelly loam over dense glacial till. Depth to dense glacial till ranges from 20 to 40 inches.

Of minor extent in this unit are Humskel and Springsteen soils on mountainsides, Klawatti soils on mountainsides and mountain ridgetops, and Jackman soils on mountains.

This unit is used as woodland and watershed. The main limitations are steepness of slope, snowpack, and seasonal soil wetness.

Broad Land Use Considerations

The soils in this survey area vary widely in their potential for major land uses. Approximately 17 percent of the land in the area is used for dairy farming and growing cultivated crops such as wheat, peas, berries, carrots, broccoli, cucumbers, cauliflower, potatoes, corn, vegetable seed, and flower bulbs. The farmland is concentrated in the western part of the survey area, in general soil map unit 1 ; smaller areas are in the central and eastern parts of the survey area, in map unit 2.

Partial protection from flooding is provided in map unit 1. Occasional and frequent flooding causes slight crop damage in map unit 2. Wetness is the major limitation for crops in map unit 1. The main soils in units 1 and 2 are those of the Skagit, Sumas, Field, Minkler, Larush, and Pilchuck series.

About 70 percent of the land in the survey area is woodland. The productivity for conifers is high on soils in general soil map units 3, 4, 5, and 6 and is moderate or low on soils in map units 7, 8, and 9. The potential productivity for conifers in map unit 1 is high, with the exception of some wet areas. The potential productivity in map unit 2 is high. Excess water in the soil during winter restricts the use of equipment on most soils. Steepness of slope is a restriction on many of the soils.

About 12,000 acres in the survey area is considered to be urban land. The urban areas are scattered throughout the area and are in general soil map units 1, 2. 3, 4. 5, and 7. The potential for increased urban buildup in map unit 1 is limited because of the hazard of flooding and soil wetness. Also, most of map unit 1 has been zoned for agricultural use. The potential for urban buildup is good in map units 4 and 7 if sewer service is expanded in these areas.

Approximately 7,000 acres of land is considered suitable for industrial sites. Most industry is located in general soil map units 1 and 7. The potential for expansion of industrial sites is fair in map unit 7 if the soil wetness problem can be overcome.

The potential for recreational use ranges from excellent to poor, depending on the type of recreation and the properties of the soil. General soil map unit 1 is poorly suited to most recreational uses because of flooding and wetness. Much of map units 3 and 5 have good potential for camp areas, picnic sites, paths and trails. and playgrounds. Steepness of slope in any of the map units limits the use of the soils for intensive recreational development, such as playgrounds and camp areas. Areas of map units 3 through 9 can be used for hiking and camping; however, steepness of slope is a limitation within much of these areas. Small areas suitable for intensive recreational development are available in map units that otherwise have low potential for recreational development.

Detailed Soil Map Units

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

A map unit delineation on a map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some "included" areas that belong to other taxonomic classes.

Most included soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavior divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included areas of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but if intensive use of small areas is planned, onsite investigation to precisely define and locate the soils and miscellaneous areas is needed.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit 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 layers, 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 layers. 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, Barneston gravelly loam, 0 to 8 percent slopes, is one of several phases in the Barneston series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Montborne-Rinker complex, 30 to 65 percent slopes, is an example.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Riverwash is an example.

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 and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

Map Unit Descriptions

1-Andic Cryochrepts-Rock outcrop complex, 65 to 90 percent slopes. This map unit is on mountainsides and ridges. The native vegetation is mainly conifers. Elevation is 2,000 to 2,900 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 40 degrees F, and the average frost-free season is 90 to 120 days.

This unit is about 70 percent Andic Cryochrepts and about 20 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 Crinker, Diobsud, Kindy, Springsteen, and Wollard soils on glaciated high mountains.

Andic Cryochrepts are moderately deep to very deep and are well drained. They formed in colluvium derived dominantly from glacial till and volcanic ash. No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of leaves and twigs about 3 inches thick. The surface layer is yellowish red very gravelly loam 3 inches thick. The upper 19 inches of the subsoil is dark yellowish brown very gravelly loam, and the lower 14 inches is dark yellowish brown very gravelly sandy loam. The substratum to a depth of 60 inches or more is olive yellow very gravelly sandy loam. Texture, content of rock fragments, and depth to dense glacial till, unconsolidated till, and bedrock vary widely within short distances.

Permeability of the Andic Cryochrepts is moderate to moderately rapid. Available water capacity is low to high. Effective rooting depth is 30 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of phyllite, argillite, or other metasedimentary rock that is hard and is mostly unweathered. Rock outcrop occurs as steep cliffs and irregular formations.

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 for western hemlock is 125. On the basis of a 50-year site curve, the mean site index for western hemlock is 89. The highest average growth rate for western hemlock is 190 cubic feet per acre per year at age 50. The areas of Rock outcrop make up about 20 percent of this unit and limit yields accordingly. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent are Pacific silver fir and western redcedar. Common forest understory plants are deer fern, tall blue huckleberry, bunchberry dogwood, devilsclub, and oneleaf foamflower.

The main limitations for the harvesting of timber are steepness of slope and the 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 soil less. Logging roads require suitable surfacing for year-round use. Occasional snowpack limits the use of equipment and restricts access. Rock for road construction is readily available on this unit. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Avoiding large areas of Rock outcrop forces yarding paths to converge, which results in compaction of the soil. Establishing plant cover on steep cuts and fills 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 they are protected by plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting western hemlock seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. The areas of Rock outcrop limit the even distribution of reforestation. When openings are made in the canopy, invading brushy

plants can delay the establishment of seedlings. Because the rooting depth in some places is restricted by the dense glacial till and bedrock, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIIe.

2-Andic Xerochrepts, 40 to 65 percent slopes. These very deep, well drained soils are on till plain escarpments. The soils formed in colluvium containing volcanic ash and are underlain by unconsolidated glacial till. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 900 to 2,100 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 110 to 135 days.

No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of leaves and twigs about 1 inch thick. The surface layer is very dark gray very gravelly silt loam 5 inches thick. The subsoil is dark brown and dark yellowish brown very gravelly loam 15 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown very gravelly loam. Texture and the content of rock fragments vary widely within short distances.

Included in this unit are small areas of Elwell, Montborne, and Sorensen soils on glaciated low mountains.

Permeability of the Andic Xerochrepts is moderate. Available water capacity is moderate to moderately high. 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 for western hemlock is 153. On the basis of a 50-year site curve, the mean site index for western hemlock is 108. The highest average growth rate for western hemlock is 243 cubic feet per acre per year at age 50. Among the trees of limited extent are Douglas fir, western redcedar, and Pacific silver fir. Common forest understory plants are western swordfern, ladyfern, vine maple, deer fern, Oregongrape, salal, and red huckleberry.

The main limitation for the harvesting of timber is steepness of slope. 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. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Occasional snowpack hinders the use of equipment and limits access in winter. Following road construction and clearcutting, road failures and landslides are likely to occur. Establishing plant cover on steep cuts and fills reduces erosion. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIIe.

3-Andic Xerochrepts-Rock outcrop complex, 65 to 90 percent slopes. This map unit is on mountainsides and canyonsides (fig. 1). The native vegetation is mainly conifers. Elevation is 900 to 2,400 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 140 days.

This unit is about 75 percent Andic Xerochrepts 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, Montborne, Oakes, Rinker. and Sorensen soils on glaciated low mountains.

The Andic Xerochrepts are very deep and well drained. They formed in colluvium derived from volcanic ash, glacial till, and phyllite, argillite, or conglomerate. No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of leaves and twigs about 1 inch thick. The surface layer is very dark gray very gravelly silt loam 6 inches thick. The subsurface layer is pinkish gray very gravelly silt loam 1 inch thick. The upper 11 inches of the subsoil is strong brown and yellowish brown very gravelly loam, and the lower 27 inches is light olive brown extremely gravelly loam. The substratum to a depth of 60 inches or more is light yellowish brown extremely gravelly loam. Texture and the content of rock fragments vary widely within short distances.

Permeability of the Andic Xerochrepts is moderate. Available water capacity is moderate to moderately high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of phyllite,

Figure 1.-Typical area of Andic Xerochrepts-Rock outcrop complex, 65 to 90 percent slopes.

argillite, or conglomerate that is hard and is mostly unweathered. Rock outcrop occurs as steep cliffs and irregular formations.

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 for western hemlock is 153. On the basis of a 50-year site curve, the mean site index for western hemlock is 108. The highest average growth rate for western hemlock is 243 cubic feet per acre per

year at age 50. The areas of Rock outcrop make up about 15 percent of this unit and limit yields accordingly. Among the trees of limited extent are Douglas fir, western redcedar, and Pacific silver fir. Common forest understory plants are Oregongrape, western swordfern, salal, and red huckleberry.

The main limitations for the harvesting of timber are steepness of slope and the areas of Rock outcrop. Cable yarding systems generally are used on this unit. Logging roads require suitable surfacing for year-round use. Material cast to the side ravels and commonly sloughs when saturated. Establishing plant cover on steep cuts and fills reduces erosion. Rock for road construction is readily available on this unit. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Avoiding large areas of Rock outcrop forces yarding paths to converge, which results in compaction of the soil.

Seedling establishment and plant competition are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock and Douglas fir seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas fir seedlings. The droughtiness of the surface layer increases the mortality rate of seedlings, especially on south- and southwest-facing side slopes. The areas of Rock outcrop limit the even distribution of reforestation.

This map unit is in capability subclass VIIe.

4-Andic Xerochrepts, warm-Rock outcrop complex, 65 to 90 percent slopes. This map unit is on the sides of valleys and canyons. The native vegetation is mainly conifers and hardwoods. Elevation is 100 to 1,200 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 145 to 180 days.

This unit is about 65 percent Andic Xerochrepts and about 25 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 Heisler, Squires, Tokul, and Vanzandt soils on glaciated uplands.

The Andic Xerochrepts are moderately deep to very deep and are well drained. They formed in colluvium derived from volcanic ash, glacial till, and phyllite, argillite, or other metasedimentary rock. No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of leaves and twigs about 1 inch thick. The surface layer is dark reddish brown gravelly silt loam 3 inches thick. The subsoil is reddish brown and yellowish brown very gravelly loam and very gravelly sandy loam 21 inches thick. The substratum to a depth of 60 inches or more is brownish yellow and olive brown extremely gravelly sandy loam. Texture, the content of rock fragments, and depth to dense glacial till and bedrock vary widely within short distances.

Permeability of the Andic Xerochrepts is moderate. Available water capacity is low to moderately high. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of phyllite, argillite, or other metasedimentary rock that is hard and is mostly unweathered. Rock outcrop occurs as steep cliffs and irregular formations.

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 for Douglas fir is 165. On the basis of a 50-year site curve, the mean site index for Douglas fir is 127. The highest average growth rate for Douglas fir is 176 cubic feet per acre per year at age 60. The areas of Rock outcrop make up about 25 percent of this unit and limit yields accordingly. Among the trees of limited extent are western hemlock and western redcedar. Common forest understory plants are western swordfern, Oregongrape, red huckleberry, and salal.

The main limitations for the harvesting of timber are the steepness of slope and the areas of Rock outcrop. Cable yarding systems generally are used on this unit. Logging roads require suitable surfacing for year-round use. Unsurfaced roads and skid trails are soft when wet. Material cast to the side ravels and commonly sloughs when saturated. Rock for road construction is readily available on this unit. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Avoiding large areas of Rock outcrop forces yarding paths to converge, which results in compaction of the soil. Establishing plant cover on steep cuts and fills reduces erosion.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas fir seedlings. The areas of Rock outcrop limit the even distribution of reforestation. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIIe.

5-Barneston gravelly loam, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on outwash terraces. It formed in loess and volcanic ash underlain by glacial outwash. The native vegetation is mainly conifers. Elevation is 250 to 1,200 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs 1 inch thick. The surface layer, where mixed to a depth of 5 inches, is brown gravelly loam. The subsoil is dark brown very gravelly loam 13 inches thick. The substratum to a depth of 60 inches or more is yellowish brown extremely gravelly sand. In some areas the surface layer is gravelly sandy loam.

Included in this unit are small areas of Norma soils in depressional areas and Birdsview and Winston soils on terraces.

Permeability of this Barneston soil is moderately rapid to the substratum and very rapid through it. 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 as woodland. It is also used as homesites, pastureland. and hayland.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 150. On the basis of a 50-year site curve, the mean site index for Douglas fir is 118. The highest average growth rate for Douglas fir is 158 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock and western redcedar. Common forest understory plants are Oregongrape, salal, western swordfern, western brackenfern, and red huckleberry.

This unit is well suited to year-round logging; however, use of wheeled and tracked equipment during the short periods when the soil is wet can produce ruts. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are 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 occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This unit is well suited to homesite development. It has few limitations. The main limitation for septic tank absorption fields is the poor filtering capacity of the soil. 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 limitation for pasture or hay is droughtiness late in summer. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This map unit is in capability subclass IIIe.

6-Barneston very gravelly sandy loam, 8 to 30 percent slopes. This very deep, somewhat excessively drained soil is on terraces and in areas between terraces. It formed in loess and volcanic ash underlain by glacial outwash. The native vegetation is mainly conifers. Elevation is 250 to 1,200 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs 1 inch thick. The surface layer, where mixed to a depth of 5 inches, is brown very gravelly sandy loam. The subsoil is dark yellowish brown very gravelly sandy loam 15 inches thick. The substratum to a depth of 60 inches or more is olive brown extremely gravelly sand. In some areas the surface layer is gravelly loam or very cobbly sandy loam. In some areas the soil is 25 to 35 inches deep to extremely gravelly sand.

Included in this unit are small areas of Birdsview and Winston soils on terraces.

Permeability of this Barneston soil is moderately rapid to the substratum and very rapid through it. 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 as woodland. It is also used as homesites, pastureland, and hayland.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 150. On the basis of a 50-year site curve, the mean site index for Douglas fir is 118. The highest average growth rate for Douglas fir is 158 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock and western redcedar. Common forest understory plants are Oregongrape, salal, western swordfern, western brackenfern, and red huckleberry.

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

Rounded pebbles and cobbles for road construction are 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 occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

If this unit is used for homesite development, the main limitation is steepness of slope. The main limitations for septic tank absorption fields are steepness of slope and the risk of 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.

The main limitations for pasture or hay are the hazard of erosion and droughtiness late in summer. 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. Seedbed preparation should be on the contour or across the slope where practical. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method for applying water.

This map unit is in capability subclass IVe.

7-Barneston very gravelly sandy loam, 30 to 65 percent slopes. This very deep, somewhat excessively drained soil is on terrace escarpments and on side slopes between terraces. It formed in loess and volcanic ash underlain by glacial outwash. The native vegetation is mainly conifers. Elevation is 250 to 1,200 feet. The average annual precipitation is about 70 inches. the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

Typically. the surface is covered with a mat of needles and twigs 1 inch thick. The surface layer, where mixed to a depth of 5 inches, is dark yellowish brown very gravelly sandy loam. The subsoil is dark yellowish brown very gravelly sandy loam 19 inches thick. The substratum to a depth of 60 inches or more is light olive brown and olive very gravelly loamy coarse sand. In some areas the surface layer is gravelly loam.

Included in this unit are small areas of Squires soils in low-lying areas on mountainsides. In some areas are soils that have a substratum that is stratified with silt and soils that have dense glacial till at a depth of 20 to 40 inches.

Permeability of this Barneston soil is moderately rapid to the substratum and very rapid through it. 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 species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 150. On the basis of a 50-year site curve, the mean site index for Douglas fir is 118. The highest average growth rate for Douglas fir is 158 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock and western redcedar. Common forest understory plants are Oregongrape, salal, western swordfern, western brackenfern, and red huckleberry.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. 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. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit. Establishing plant cover on steep cuts and fills reduces erosion.

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 occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIe.

8-Barneston very cobbly sandy loam, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in loess and volcanic ash underlain by glacial outwash. The native vegetation is mainly conifers. Elevation is 250 to 1,200 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs 1 inch thick. The surface layer, where mixed to a depth of 5 inches, is brown very cobbly sandy loam. The subsoil is brown and dark brown very cobbly sandy loam 13 inches thick. The substratum to a depth of 60 inches or more is grayish brown and light olive brown very cobbly loamy sand. Depth to very cobbly loamy sand ranges from 17 to 25

inches. In some areas the surface layer is very gravelly sandy loam.

Included in this unit are small areas of Gilligan and Indianola soils on glacial outwash terraces and Larush soils on recent alluvial terraces.

Permeability of this Barneston soil is moderately rapid to a depth of 18 inches and very rapid below this depth. 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 as woodland. It is also used as homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 124. On the basis of a 50-year site curve, the mean site index for Douglas fir is 101. The highest average growth rate for Douglas fir is 121 cubic feet per acre per year at age 70. Among the trees of limited extent are western hemlock and western redcedar. Common forest understory plants are Oregongrape, salal, western swordfern, western brackenfern, and red huckleberry.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are 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 occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

The main limitation of this unit for use as homesites is the presence of large stones that interfere with excavation. The main limitations for septic tank absorption fields are the large stones and the risk of 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 VIs.

9-Beaches. This map unit consists of coastal beaches. Areas are long, narrow, and nearly level and are 4 to 20 acres in size. Most areas are not vegetated, but some areas support scattered grasses. Elevation is 0 to 5 feet. The average annual precipitation is about 25 inches. the average annual air temperature is about 50 degrees F. and the average frost-free season is 175 to 210 days.

Typically, Beaches consists of multicolored, stratified sand with lenses of clam, crab, and oyster shells. The water table fluctuates from above the surface to a depth of more than 5 feet below the surface. Permeability is rapid. Available water capacity is low. Surface runoff is slow. The organic matter content is very low. Some nutrients are not available to plants because of the alkalinity of the sand.

Most areas of this unit are used for recreation. Some areas are used for wildlife habitat.

This map unit is in capability subclass VIIIw.

10-Bellingham silt loam. This very deep, poorly drained soil is in depressional areas. It formed in alluvial and lacustrine material. Slope is 0 to 3 percent. The native vegetation is mainly mixed hardwoods and conifers. Elevation is near sea level to 450 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 170 to 210 days.

Typically, the surface layer is very dark gray silt loam 9 inches thick. The upper 12 inches is gray silty clay loam, and the lower 12 inches is dark gray silty clay. The substratum to a depth of 60 inches or more is dark bluish gray silty clay. In some places are small areas where gravel is in the profile, areas where the surface layer is less than 6 inches thick, and areas where strata of fine sand are in the substratum.

Included in this unit are small areas of Norma soils along drainageways, Skipopa soils on terraces. Bellingham mucky silt loam, and Bellingham silt loam that is drained.

Permeability of this Bellingham soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at the surface to a depth of 12 inches below the surface from November to April. In some places this soil is subject to ponding during the rainy season. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland and wildlife habitat. It is also used as pastureland and hayland.

Red alder is the main woodland species on this unit. On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 85. The highest average growth rate for red alder is 92 cubic feet per acre per year at age 40. Among the trees of limited extent are western redcedar and western hemlock. Common forest understory plants are western swordfern, salmonberry, sedges, and other perennial forbs and shrubs.

The main limitation for the harvesting of timber is wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and

damages the roots of trees. Unsurfaced roads and skid trails are soft and slippery when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Use of equipment is limited to dry periods.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting western redcedar seedlings. The seasonal high water table reduces root respiration, which results in a low survival rate of seedlings. Trees are frequently subject to windthrow during periods when the soil is excessively wet and the winds are strong. When openings are made in the canopy, brushy plants can prevent the establishment of red alder.

The main limitation for pasture or hay is the seasonal perched water table. Tile drains and field ditches are needed to lower the water table if deep-rooted plants are grown. Drainage tiles should be closely spaced because of the slow permeability. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

This map unit is in capability subclass Vlw.

11-Bellingham mucky silt loam. This very deep, poorly drained soil is in depressional areas. It formed in alluvial and lacustrine material. Slope is 0 to 2 percent. The native vegetation is mainly mixed hardwoods and conifers. Elevation is near sea level to 450 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 170 to 210 days.

Typically, the surface layer is very dark gray mucky silt loam 9 inches thick. The upper 12 inches of the subsoil is gray silty clay loam, and the lower 12 inches is dark gray silty clay. The substratum to a depth of 60 inches or more is dark bluish gray silty clay. In some small areas gravel is in the profile, the surface layer is thin, or strata of fine sand are in the substratum.

Included in this unit are small areas of Norma soils along drainageways, Skipopa soils on terraces, and Mukilteo soils and Terric Medisaprists in depressional areas.

Permeability of this Bellingham soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at or above the surface from November to April. This soil is subject to ponding during the rainy season. Runoff is ponded, and the hazard of water erosion is slight.

This unit is used as woodland and wildlife habitat. Red alder is the main woodland species on this unit. On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 85. The highest average growth rate for red alder is 92 cubic feet per acre per year at age 40. Among the trees of limited extent are western redcedar and western hemlock. Common forest understory plants are western swordfern, salmonberry, and other perennial forbs and shrubs.

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

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting western redcedar seedlings. Ponding reduces root respiration, which results in a low survival rate of seedlings. Trees are frequently subject to windthrow during periods when the soil is excessively wet and the winds are strong. When openings are made in the canopy, invading brushy plants can prevent the establishment of red alder.

This map unit is in capability subclass Vlw.

12-Birdsview loamy sand, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in glacial outwash. The native vegetation is mainly conifers. Elevation is 200 to 1,000 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 220 days.

Typically, the surface is covered with a mat of leaves, needles, and twigs 4 inches thick. The surface layer is dark brown loamy sand 5 inches thick. The upper 25 inches of the subsoil is dark yellowish brown loamy sand, and the lower 24 inches is dark yellowish brown sand. The substratum to a depth of 60 inches or more is olive brown and olive gray sand. In some areas the surface layer is gravelly loamy sand. In some areas pumice is in the profile.

Included in this unit are small areas of Barneston soils on terraces.

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

Most areas of this unit are used as woodland. A few areas are used as hayland, pastureland, and homesites.

Douglas fir is the main woodland species on this unit.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 165. On the basis of a 50-year site curve, the mean site index for Douglas fir is 125. The highest average growth rate for Douglas fir is 176 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock and western redcedar. Common forest understory plants are Oregongrape, western swordfern, bunchberry dogwood, red huckleberry, and Pacific dogwood.

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. The surface layer is loose when dry, which hinders the use of wheeled and tracked equipment.

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 occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

The main limitations for pasture and hay are droughtiness and low soil fertility. Rotation grazing helps to maintain the quality of forage. Periodic mowing helps to maintain uniform growth, discourages selective grazing, and reduces weeds. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is well suited to homesite development. The main limitation for septic tank absorption fields is the risk of 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 IVs.

13-Birdsview loamy sand, 50 to 80 percent slopes. This very deep, somewhat excessively drained soil is on terrace escarpments. It formed in glacial outwash. The native vegetation is mainly conifers and mixed hardwoods. Elevation is 200 to 1,000 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 220 days.

Typically, the surface is covered with a mat of leaves, needles, and twigs 4 inches thick. The surface layer is dark brown loamy sand 5 inches thick. The upper 25 inches of the subsoil is dark yellowish brown loamy sand, and the lower 24 inches is dark yellowish brown sand. The substratum to a depth of 60 inches or more is olive and olive gray sand. In some areas the surface layer is gravelly loamy sand. In some areas strata of clay are in the subsoil and gray soil material is in the subsoil and substratum.

Included in this unit are small areas of Barneston soils on outwash terraces, Larush soils on alluvial terraces, and Tokul soils on glaciated uplands.

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

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 for Douglas fir is 143. On the basis of a 50-year site curve, the mean site index for Douglas fir is 115. The highest average growth rate for Douglas fir is 149 cubic feet per acre per year at age 65. Among the trees of limited extent are western hemlock and western redcedar. Common forest understory plants are Oregongrape, western swordfern, bunchberry dogwood, red huckleberry, and Pacific dogwood.

The main limitation for the harvesting of timber is steepness of slope. 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 surface layer is loose when dry, which hinders the use of wheeled and tracked equipment. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided.

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 occurs periodically. The droughtiness of the surface layer increases the mortality rate of seedlings, especially on south- and southwest-facing side slopes. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIIs.

14-Blethen very gravelly silt loam, 30 to 65 percent slopes. This deep, well drained soil is on glacially modified mountainsides. It formed in colluvium derived from argillite containing volcanic ash and glacial till. The native vegetation is mainly conifers. Elevation is 200 to 1,200 feet. The average annual precipitation is about 70 inches, the average annual air temperature is

about 48 degrees F. and the average frost-free season is 140 to 180 days.

Typically, the surface is covered with a mat of leaves and twigs 3 inches thick. The surface layer, where mixed to a depth of 6 inches, is dark brown very gravelly silt loam. The subsoil is dark brown, strong brown, and dark yellowish brown very gravelly silt loam 31 inches thick. The substratum is light olive brown extremely gravelly loam about 12 inches thick. Argillite is at a depth of about 49 inches. Depth to argillite ranges from 40 to 60 inches. In some areas the surface layer is very gravelly loam.

Included in this unit are small areas of Squires and Vanzandt soils and Rock outcrop on mountainsides.

Permeability of this Blethen soil is moderate. Available water capacity is low to moderately high. Effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

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 for Douglas fir is 149. On the basis of a 50-year site curve, the mean site index for Douglas fir is 115. The highest average growth rate for Douglas fir is 157 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Common forest understory plants are western swordfern, red huckleberry, deer fern, Oregongrape, bedstraw, salmonberry, and Pacific trillium.

The main limitations for the harvesting of timber are steepness of slope and seasonal soil wetness. Material cast to the side ravels and commonly sloughs when saturated. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Logging roads require suitable surfacing for year-round use. Rock for road construction is 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 occurs periodically. When openings are made in the canopy., invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIe.

15-Borohemists, 0 to 3 percent slopes. These very deep, very poorly drained soils are in depressional areas on low mountains. The soils formed in mixed organic material consisting of mosses, forbs, and shrubs. The native vegetation is mainly willows, shrubs, and forbs. Elevation is 1,000 to 2,200 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 135 days.

No single profile is representative of these soils, but one commonly observed in the survey area has a surface layer of black mucky peat about 8 inches thick. The upper 22 inches of underlying material is reddish brown hemic material, and the lower part to a depth of 60 inches or more is variable mineral or organic material. The thickness of organic material ranges from 16 inches to more than 60 inches. In some small areas the soils have an underlying layer of dense glacial till, clay, or stratified sand.

Included in this unit are small areas of Elwell soils on low glaciated mountains.

Permeability of these Borohemists is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that fluctuates from above the surface to a depth of 12 inches below the surface from October to June. These soils are subject to ponding during the rainy season. Runoff is ponded, and the hazard of water erosion is slight.

This unit is used as wildlife habitat.

This map unit is in capability subclass Vw.

16-Bow gravelly loam, 0 to 3 percent slopes. This very deep, somewhat poorly drained soil is on glaciated terraces and undulating till plains. It formed in glaciolacustrine material and gravelly glacial drift mantled with volcanic ash. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 50 to 400 feet. The average annual precipitation is about 30 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

Typically, the surface layer is dark brown gravelly loam 7 inches thick. The upper 10 inches of the subsoil is dark brown very gravelly loam, the next 14 inches is grayish brown clay loam, olive gray silty clay, and light olive gray silt loam, and the lower part to a depth of 60 inches or more is olive gray silty clay. In some areas the surface layer is gravelly silt loam or black gravelly loam about 9 inches thick, and in some areas the subsoil is loamy.

Included in this unit are small areas of Bellingham soils in wet depressional areas and along drainageways and Catla and Clallam soils on knolls.

Permeability of this Bow soil is slow. Available water

capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 6 to 18 inches from November to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as hayland, pastureland, woodland, and homesites. If adequately drained, the unit is suited to climatically adapted cultivated crops.

The main limitation for hay and pasture is seasonal wetness. The water table limits the use of this unit to grasses and shallow-rooted legumes. Tile drains and field ditches are needed to reduce wetness if deep-rooted plants are grown. Drainage tiles should be closely spaced because of the slow permeability. Shallow ditches help to remove surface water and prevent ponding. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 131. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 107. The highest average growth rate for Douglas fir is 132 cubic feet per acre per year at age 70. Among the trees of limited extent are red alder, western redcedar, and western hemlock. Common forest understory plants are salal, trailing blackberry, evergreen huckleberry, western swordfern, creambush oceanspray, and northern twinflower.

The main limitation for the harvesting of timber is seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. When wet, unsurfaced roads and skid trails are sticky and slippery and they can be impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment and the hazard of windthrow are the main concerns 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. Wetness reduces root respiration, which results in a low survival rate of seedlings. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Because the rooting depth is restricted by the perched water table and the clay layer, trees frequently are subject to windthrow.

This unit is poorly suited to homesite development. The main limitations are wetness and shrink-swell potential. Wetness can be reduced by installing drain tile around footings. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential. The main limitations for septic tank absorption fields are slow permeability and wetness. Use of interceptor drains, additional topsoil placed over the absorption field, and longer absorption lines helps to compensate for these limitations.

This map unit is in capability subclass IIIw.

17-Bow gravelly loam, 3 to 8 percent slopes. This very deep, somewhat poorly drained soil is on glaciated terraces and undulating till plains. It formed in glaciolacustrine material and gravelly glacial drift mantled with volcanic ash. The vegetation in areas not cultivated is mainly conifers. Elevation is 50 to 400 feet. The average annual precipitation is about 30 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

Typically, the surface layer is dark brown gravelly loam 7 inches thick. The upper 10 inches of the subsoil is dark brown very gravelly loam, the next 14 inches is grayish brown clay loam, olive gray silty clay, and light olive gray silt loam, and the lower part to a depth of 60 inches or more is olive gray silty clay. In some areas the surface layer is gravelly silt loam or black gravelly loam about 9 inches thick, and in some areas the subsoil is loamy.

Included in this unit are small areas of Catla and Clallam soils on knolls and Swinomish soils on ridges of hills.

Permeability of this Bow soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 6 to 18 inches from November to May. Runoff is medium, and the hazard of water erosion is slight.

This unit is used as hayland, pastureland, woodland, and homesites. If adequately drained, the unit is suited to climatically adapted cultivated crops.

The main limitation for hay and pasture is seasonal wetness. The water table limits the use of this unit to grasses and shallow-rooted legumes. Tile drains and field ditches are needed to lower the perched water table if deep-rooted plants are grown. Drainage tiles should be closely spaced because of the slow permeability. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 131. On the

basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 107. The highest average growth rate for Douglas fir is 132 cubic feet per acre per year at age 70. Among the trees of limited extent are red alder. western redcedar, and western hemlock. Common forest understory plants are salal, trailing blackberry, evergreen huckleberry, western swordfern, creambush oceanspray, and northern twinflower.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. When wet, unsurfaced roads and skid trails are sticky and slippery and they can be impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment and the hazard of windthrow are the main concerns 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 perched water table reduces root respiration, which results in a low survival rate of seedlings. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Because the rooting depth is restricted by the perched water table and the clay layer, trees frequently are subject to windthrow.

This unit is poorly suited to homesite development. The main limitations are wetness and shrink-swell potential. Wetness can be reduced by installing drain tile around footings. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential. The main limitations for septic tank absorption fields are slow permeability and the perched water table. Use of interceptor drains, additional topsoil placed over the absorption field, and longer absorption lines placed on the contour helps to compensate for these limitations.

This map unit is in capability subclass IIIw.

18-Bow gravelly loam, low precipitation, 0 to 3 percent slopes. This very deep, somewhat poorly drained soil is on glacially modified remnant terraces and hills. It formed in gravelly glacial drift over glaciolacustrine material mantled with volcanic ash. The vegetation in areas not cultivated is mainly conifers and deciduous trees. Elevation is near sea level to 200 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

Typically, the surface is covered with a mat of leaves and twigs 1 inch thick. The surface layer is dark brown gravelly loam 5 inches thick. The upper 3 inches of the subsoil is brown gravelly loam, the next 14 inches is dark grayish brown clay loam, and the lower part to a depth of 60 inches or more is gray silty clay. In some areas the surface layer is gravelly silt loam or is black to dark brown gravelly loam about 9 inches thick, and in some areas the subsoil is gravelly and loamy.

Included in this unit are small areas of Catla and Clallam soils on hills, Bellingham soils in depressional areas, and Laconner soils on terraces.

Permeability of this Bow soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 6 to 18 inches from November to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland, pastureland, hayland, and homesites. If adequately drained, it is suited to climatically adapted cultivated crops.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 126. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 94. The highest average growth rate for Douglas fir is 124 cubic feet per acre per year at age 70. Among the trees of limited extent are western redcedar, red alder, grand fir, and western hemlock. Common forest understory plants are salal, trailing blackberry, evergreen huckleberry, western swordfern, creambush oceanspray, and northern twinflower.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. When wet, unsurfaced roads and skid trails are sticky and slippery and they can be impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment and the hazard of windthrow are the main concerns 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 perched water table reduces root respiration, which results in a low survival rate of seedlings. When openings are made in the canopy, invading brushy plants can prevent the establishment of

seedlings. Because the rooting depth is restricted by the perched water table and the clay layer, trees frequently are subject to windthrow.

If this unit is used for hay and pasture, the main limitation is the perched water table. The water table limits use of the unit to grasses and shallow-rooted legumes. Tile drains and field ditches are needed to lower the water table if deep-rooted plants are grown. Drainage tiles should be closely spaced because of the slow permeability. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Shallow ditches help to remove surface water and prevent ponding in winter. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is poorly suited to homesite development. The main limitations are wetness and shrink-swell potential. Soil wetness can be reduced by installing drain tile around footings. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential. The main limitations for septic tank absorption fields are slow permeability and the perched water table. Use of interceptor drains, additional topsoil placed over the absorption field, and longer absorption lines helps to compensate for these limitations.

This map unit is in capability subclass IIIw.

19-Bow gravelly loam, low precipitation, 3 to 8 percent slopes. This very deep, somewhat poorly drained soil is on glacially modified remnant terraces and hills. It formed in gravelly glacial drift over glaciolacustrine material mantled with volcanic ash. The vegetation in areas not cultivated is mainly coniferous and deciduous trees. Elevation is near sea level to 200 feet. The average annual precipitation is about 23 inches. the average annual air temperature is about 50 degrees F. and the average frost-free season is 170 to 220 days.

Typically, the surface is covered with a mat of leaves and twigs 1 inch thick. The surface layer is dark brown gravelly loam 5 inches thick. The upper 3 inches of the subsoil is brown gravelly loam, the next 14 inches is dark grayish brown clay loam, and the lower part to a depth of 60 inches or more is gray silty clay. In some areas the surface layer is gravelly silt loam or is black to dark brown gravelly loam about 9 inches thick, and in some areas the subsoil is gravelly and loamy.

Included in this unit are small areas of Catla and Clallam soils on hills and Laconner soils on terraces.

Permeability of this Bow soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 6 to 18 inches from November to May. Runoff is medium, and the hazard of water erosion is slight.

This unit is used as woodland, pastureland, hayland, and homesites. If adequately drained, it is suited to climatically adapted cultivated crops.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 126. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 94. The highest average growth rate for Douglas fir is 122 cubic feet per acre per year at age 70. Among the trees of limited extent are western redcedar, red alder, grand fir, and western hemlock. Common forest understory plants are salal, trailing blackberry, evergreen huckleberry, western swordfern, creambush oceanspray, and northern twinflower.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. When wet, unsurfaced roads and skid trails are sticky and slippery and they can be impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment and the hazard of windthrow are the main concerns 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 perched water table reduces root respiration. which results in a low survival rate of seedlings. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Because the rooting depth is restricted by the perched water table and the clay layer, trees frequently are subject to windthrow.

If this unit is used for hay and pasture, the main limitation is the perched water table. The water table limits use of the unit to grasses and shallow-rooted legumes. Tile drains and field ditches are needed to lower the perched water table if deep-rooted plants are grown. Drainage tiles should be closely spaced because of the slow permeability. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. In

summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is poorly suited to homesite development. The main limitations are wetness and shrink-swell potential. Wetness can be reduced by installing drain tile around footings. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential. The main limitations for septic tank absorption fields are the slow permeability and perched water table. Use of interceptor drains, additional topsoil placed over the absorption field. and longer absorption lines placed on the contour helps to compensate for these limitations.

This map unit is in capability subclass IIIw.

20-Bow-Urban land complex, 0 to 8 percent slopes. This map unit is on glaciated terraces and hills. Slopes are broad and smooth with concave areas. The native vegetation is mainly conifers and deciduous shrubs. Elevation is 5 to 150 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

This unit is about 60 percent Bow gravelly loam, low precipitation, 0 to 8 percent slopes, and about 35 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 Bellingham soils in depressional areas and along drainageways and Catla and Clallam soils on glaciated hills.

The Bow soil is very deep and somewhat poorly drained. It formed in glaciolacustrine material derived dominantly from glacial till and lake sediment mantled with volcanic ash. Typically, the surface layer is dark brown gravelly loam 7 inches thick. The upper 10 inches of the subsoil is dark brown very gravelly loam; the next 14 inches is grayish brown clay loam, olive gray silty clay, and light olive gray silt loam; and the lower part to a depth of 60 inches or more is olive gray silty clay. In some areas the surface layer is gravelly silt loam or is black, and in some areas the subsoil is loamy.

Permeability of the Bow soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 6 to 18 inches from November to May. Runoff is medium, and the hazard of water erosion is slight.

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

The Bow soil in this unit is used as open spaces, parks, building sites, lawns, and gardens.

If the Bow soil is used for homesite development, the main limitations are wetness and shrink-swell potential. Wetness can be reduced by installing drain tile around footings. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential. The main limitations for septic tank absorption fields are slow permeability and the perched water table. Use of interceptor drains, additional topsoil placed over the absorption field, and longer absorption lines placed on the contour helps to compensate for these limitations.

This map unit is in capability subclass IIIw.

21-Briscot fine sandy loam. This very deep, poorly drained soil is on flood plains. Drainage has been altered by tiling. The soil formed in alluvium. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 5 to 45 feet. The average annual precipitation is about 32 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface layer is dark grayish brown fine sandy loam 16 inches thick. The upper 14 inches of the underlying material is grayish brown, stratified loamy fine sand and silt loam, and the lower part to a depth of 60 inches or more is olive gray silt loam. In some areas the surface layer is loamy fine sand, and in some areas the underlying material is dominantly silt loam.

Included in this unit are small areas of Sumas soils on flood plains.

Permeability of this Briscot soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 36 feet from November to April. Runoff is slow, and the hazard of water erosion is slight. Flooding is rare in areas protected by dikes; however, this soil may be subject to frequent, long periods of flooding in areas not protected by dikes.

This unit is used as cropland, hayland, and pastureland.

This unit is well suited to use as cropland, hayland, and pastureland if dikes and drainage systems are maintained. In summer supplemental irrigation is required for maximum production. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, fertility, and tilth. Use of proper stocking rates, pasture rotation, and restricted

grazing during wet periods helps to keep the pasture in good condition.

This unit has potential for use as woodland. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 150. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 115. The potential highest average growth rate for Douglas fir is 158 cubic feet per acre per year at age 60. Other tree species adapted to the soil in this unit are red alder, western redcedar, and western hemlock. Potentially adapted forest understory plants are western swordfern, western brackenfern, salal, vine maple, trailing blackberry. rose, northern bedstraw, and northern twinflower.

This map unit is in capability subclass IIw.

22-Cathcart loam, 8 to 15 percent slopes. This very deep. well drained soil is on till plains and foothills. It formed in volcanic ash, glacial till, and colluvium derived from sandstone. The native vegetation is mainly conifers and hardwoods. Elevation is 300 to 1,300 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 160 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is reddish brown loam 10 inches thick. The subsoil is dark brown and dark yellowish brown loam 30 inches thick. The substratum to a depth of 60 inches or more is light olive brown gravelly sandy loam. In some areas this soil does not have properties that are associated with weathered volcanic ash.

Included in this unit are small areas of Tokul soils on hills, soils that have siltstone at a depth of 20 to 40 inches. Bellingham soils in depressional areas, and Norma soils in drainageways. Also included are small areas of Cathcart soils that have slopes of less than 8 percent.

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 as hayland, pastureland, and homesites. The unit is also suited to climatically adapted cultivated crops.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 173. On the basis of a 50-year site curve, the mean site index for Douglas fir is 130. The highest average growth rate for Douglas fir is 184 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Common forest understory plants are western swordfern, salal, red huckleberry, trailing blackberry, and western brackenfern.

The main limitation for the harvesting of timber is muddiness caused by soil wetness during the rainy season. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Logging roads require suitable surfacing for year-round use. Unsurfaced roads and skid trails are soft when wet. Rock for road construction is not readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated.

Seedling establishment 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 can prevent the establishment of seedlings. If seed trees are present, natural reforestation of cutover areas by Douglas fir and red alder occurs periodically.

The main limitation for hay and pasture is the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. Seedbed preparation should be on the contour or across the slope where practical.

The main limitation of this unit for use as homesites is steepness of slope. Excavation for roads and buildings increases the hazard of erosion. Structures to divert runoff are needed if buildings and roads are constructed. The main limitations for septic tank absorption fields are steepness of slope and moderate permeability. Use of longer absorption lines and lines placed on the contour helps to compensate for these limitations. Effluent from septic tank absorption fields can surface in downslope areas and thus create a hazard to health.

This map unit is in capability subclass IIIe.

23-Cathcart loam, 15 to 30 percent slopes. This very deep, well drained soil is on till plains and foothills. It formed in volcanic ash, glacial till, and colluvium derived dominantly from sandstone. The native vegetation is mainly conifers. Elevation is 300 to 1,300 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 160 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is reddish brown loam 10 inches thick. The subsoil

is dark brown and dark yellowish brown loam 30 inches thick. The substratum to a depth of 60 inches or more is light olive brown gravelly sandy loam.

Included in this unit are small areas of soils that are clay loam underlain by weathered siltstone at a depth of 20 to 40 inches and soils that have a dense glacial till layer at a depth of 20 to 40 inches. Also included are some areas of soils that have more than 35 percent hard rock fragments in the profile and do not have properties associated with weathered volcanic ash.

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.

Most areas of this unit are used as woodland. A few areas are used as hayland, pastureland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 173. On the basis of a 50-year site curve, the mean site index for Douglas fir is 130. The highest average growth rate for Douglas fir is 184 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Common forest understory plants are western swordfern, salal, red huckleberry, trailing blackberry, and western brackenfern.

The main limitation for the harvesting of timber is muddiness caused by soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Logging roads require suitable surfacing for year-round use. Unsurfaced roads and skid trails are soft when wet. Rock for road construction is not readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated.

Seedling establishment 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 can prevent the establishment of seedlings. If seed trees are present, natural reforestation of cutover areas by Douglas fir and red alder occurs periodically.

The main limitation of this unit for hay and pasture is the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. Seedbed preparation should be on the contour or across the slope where practical.

This unit is poorly suited to homesite development. The main limitation is steepness of slope. Excavation for roads and buildings increases the risk of erosion. Structures to divert runoff are needed if buildings and roads are constructed. Septic tank absorptions fields do not function properly because of the steepness of slope. This map unit is in capability subclass IVe.

24-Cathcart loam, 30 to 65 percent slopes. This very deep, well drained soil is on glaciated mountainsides. This soil formed in volcanic ash, glacial till, and colluvium derived dominantly from sandstone. The native vegetation is mainly conifers and hardwood trees. Elevation is 300 to 1,300 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 160 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown loam 7 inches thick. The subsoil is dark brown and dark yellowish brown loam 32 inches thick. The substratum to a depth of 60 inches or more is yellowish brown and light olive brown gravelly loam. In some areas the surface layer is sandy loam. In some areas the substratum is loamy sand, the surface layer does not have properties associated with weathered volcanic ash, or the soil is more than 35 percent hard rock fragments.

Included in this unit are small areas of soils that are less than 40 inches deep to siltstone and Tokul soils on hills.

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 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 for Douglas fir is 173. On the basis of a 50-year site curve, the mean site index for Douglas fir is 130. The highest average growth rate for Douglas fir is 184 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Among the common forest understory plants are western swordfern, salal, red huckleberry, trailing blackberry, and western brackenfern.

The main limitation for the harvesting of timber is steepness of slope. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided. Logging roads require suitable surfacing for year-round

use. Rock for road construction is not readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated.

Seedling establishment 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 can prevent the establishment of seedlings. If seed trees are present, natural reforestation of cutover areas by Douglas fir and red alder occurs periodically.

This map unit is in capability subclass Vle.

25-Catla gravelly fine sandy loam, 0 to 8 percent slopes. This shallow, moderately well drained soil is on hills. It formed in very compact glacial till. Slopes are dominantly 0 to 3 percent. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 500 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick, The surface layer. where mixed to a depth of 6 inches, is dark grayish brown gravelly fine sandy loam. The upper 5 inches of the subsoil is dark yellowish brown gravelly fine sandy loam, and the lower 6 inches is dark yellowish brown very gravelly loam. Olive gray, dense glacial till that crushes to very cobbly loam is at a depth of about 17 inches. Depth to dense glacial till ranges from 10 to 20 inches. In some areas the substratum is very gravelly sand, and in some areas very gravelly sand is below a thin layer of dense glacial till.

Included in this unit are small areas of Coveland soils in swales and Clallam soils on hills.

Permeability of this Catla soil is moderate above the dense glacial till and very slow through the till. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is slow, and the hazard of water erosion is slight. A perched water table fluctuates between depths of 6 and 18 inches from November to May.

This unit is used as woodland, hayland, and pastureland.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 104. On the basis of a 50-year site curve, the mean site index for Douglas fir is 82. The highest average growth rate for Douglas fir is 89 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, grand fir, Pacific madrone, and red alder. Common forest understory plants are salal, creambush oceanspray, rose, willow, western brackenfern, blackberry, and evergreen huckleberry.

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

Seedling mortality and the hazard of windthrow are the main concerns 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 perched water table reduces root respiration, which results in a low survival rate of seedlings. High soil temperature and the very low available water capacity during the growing season can result in a high mortality rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by the dense glacial till layer, trees frequently are subject to windthrow.

The main limitations for hay and pasture are the restricted rooting depth and droughtiness. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This map unit is in capability subclass Vle.

26-Catla gravelly fine sandy loam, 8 to 15 percent slopes. This shallow, moderately well drained soil is on hills. It formed in very compact glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 500 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer, where mixed to a depth of 6 inches, is dark grayish brown gravelly fine sandy loam. The upper 5 inches of the subsoil is dark yellowish brown gravelly fine sandy loam, and the lower 6 inches is dark yellowish brown very gravelly loam. Olive gray, dense glacial till that crushes to very cobbly loam is at a depth of about 17 inches. Depth to dense glacial till ranges

from 10 to 20 inches. In some areas the substratum is very gravelly sand, and in some areas very gravelly sand is below a thin layer of dense glacial till.

Included in this unit are small areas of Coveland soils in swales and Clallam soils on hills.

Permeability of this Catla soil is moderate above the dense glacial till and very slow through the till. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. A perched water table fluctuates between depths of 6 and 18 inches from November to May.

This unit is used as woodland, hayland, and pastureland.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 104. On the basis of a 50-year site curve, the mean site index for Douglas fir is 82. The highest average growth rate for Douglas fir is 89 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, grand fir. Pacific madrone, and red alder. Common forest understory plants are salal, creambush oceanspray, rose, willow, western brackenfern, blackberry, and evergreen huckleberry.

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

Seedling mortality and the hazard of windthrow are the main concerns 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 perched water table reduces root respiration, which results in a low survival rate of seedlings. High soil temperature and the very low available water capacity during the growing season can result in a high mortality rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by the dense glacial till layer, trees frequently are subject to windthrow.

The main limitations for hay and pasture are the hazard of erosion, restricted rooting depth, and droughtiness. 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. Seedbed preparation should be on the contour or across the slope where practical. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This map unit is in capability subclass VIe.

27-Chuckanut gravelly loam, 8 to 30 percent slopes. This deep, well drained soil is on hills. It formed in volcanic ash and colluvium derived from sandstone and glacial till. The native vegetation is mainly conifers and mixed hardwoods. Elevation is 800 to 1,500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 7 inches thick. The surface layer, where mixed to a depth of 9 inches, is dark yellowish brown gravelly loam. The upper 6 inches of the subsoil is dark yellowish brown gravelly loam, and the lower 20 inches is olive brown gravelly sandy loam. The substratum is olive brown gravelly loam about 14 inches thick. Sandstone is at a depth of about 49 inches. Depth to sandstone ranges from 40 to 60 inches. In some areas the subsoil is clay loam or very gravelly sandy loam.

Included in this unit are small areas of Bellingham and Mukilteo soils in drainageways and depressional areas, Rock outcrop, and Chuckanut soils that have slopes of more than 30 percent and are along the sides of ridges. Also included are small areas of Sehome and Tokul soils on hills.

Permeability of this Chuckanut soil is moderate. Available water capacity is moderately high to high. Effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

Most areas of this unit are used as woodland. A few areas are used as hayland and pastureland.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 172. On the basis of a 50-year site curve, the mean site index for Douglas fir is 128. The highest average growth rate for Douglas fir is 183 cubic feet per acre per year at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Common forest understory plants are salal, western brackenfern, western swordfern, Oregongrape, and red huckleberry.

The main limitation for the harvesting of timber is muddiness caused by soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts. compacts the soil, and damages roots of trees. 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 cuts and fills reduces erosion.

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 periodically. The mortality rate of seedlings is higher on ridgetops that are subject to strong. persistent winds than it is in other areas of this unit. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas fir seedlings.

The main limitation for hay and pasture is the hazard of erosion. Use of proper stocking rates, pasture rotation, and restricted grazing during the wet periods helps to keep the pasture in good condition and to protect the soil from erosion. Seedbed preparation should be on the contour or across the slope where practical. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method for applying water.

This map unit is in capability subclass lVe.

28-Chuckanut gravelly loam, 30 to 65 percent slopes. This deep. well drained soil is on hills and mountainsides. It formed in volcanic ash and colluvium derived from sandstone and glacial till. The native vegetation is mainly conifers and mixed hardwoods. Elevation is 800 to 1,500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 160 to 200 days.

Typically. the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer. where mixed to a depth of 9 inches, is dark yellowish brown gravelly loam. The upper 6 inches of the subsoil is dark yellowish brown gravelly loam, and the lower 20 inches is olive brown gravelly sandy loam. The substratum is olive brown gravelly loam about 14 inches thick. Sandstone is at a depth of about 49 inches. Depth to sandstone ranges from 40 to 60 inches. In some areas the surface layer is gravelly sandy loam, and in some areas the subsoil and substratum are very gravelly sandy loam.

Included in this unit are small areas of Mukilteo soils in depressional areas and small areas of Rock outcrop and Sehome and Tokul soils on hills.

Permeability of this Chuckanut soil is moderate. Available water capacity is moderately high to high. Effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

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 for Douglas fir is 172. On the basis of a 50-year site curve, the mean site index for Douglas fir is 128. The highest average growth rate for Douglas fir is 183 cubic feet per acre per year at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Common forest understory plants are salal, western brackenfern, western swordfern, Oregongrape, and red huckleberry.

The main limitation for the harvesting of timber is steepness of slope. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. 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 periodically. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass Vle.

29-Clallam gravelly loam, 0 to 8 percent slopes. This moderately deep. moderately well drained soil is on hills. It formed in very compact glacial till. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 25 to 500 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface

layer, where mixed to a depth of 6 inches, is dark brown gravelly loam. The upper 5 inches of the subsoil is dark brown gravelly loam, and the lower 5 inches is olive brown very gravelly loam. The substratum is grayish brown very gravelly loam about 11 inches thick. Dense glacial till that crushes to very gravelly fine sandy loam is at a depth of about 27 inches. Depth to dense glacial till ranges from 20 to 40 inches.

Included in this unit are small areas of Bow soils on remnant glaciated terraces, Coveland soils in swales on hills. and Swinomish and Catla soils on ridges and hills.

Permeability of this Clallam soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A perched water table fluctuates between depths of 18 and 36 inches from January to April.

This unit is used as woodland, hayland, pastureland, and homesites. It is also suited to climatically adapted cultivated crops.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 130. On the basis of a 50-year site curve. the mean site index for Douglas fir is 98. The highest average growth rate for Douglas fir is 130 cubic feet per acre per year at age 70. Among the trees of limited extent are western hemlock, grand fir, western redcedar, red alder, and Pacific madrone. Common forest understory plants are salal, red huckleberry, Oregongrape, creambush oceanspray, western brackenfern, northern twinflower, and western swordfern.

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

Seedling establishment and the hazard of windthrow are the main concerns 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 periodically. High soil temperature and restricted available water capacity of the soil during the growing season can result in a high mortality rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

The main limitation for hay and pasture is droughtiness. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

If this unit is used for homesite development, the main limitations are depth to the dense glacial till and seasonal soil wetness. Wetness can be reduced by installing drain tile around footings. Excavation for building sites is limited by the dense glacial till. The main limitations for septic tank absorption fields are the depth to the dense glacial till and the perched water table. Use of interceptor drains, additional topsoil placed over the absorption field, and longer absorption lines placed on the contour helps to compensate for these limitations.

This map unit is in capability subclass IVe.

30-Clallam gravelly loam, 8 to 15 percent slopes. This moderately deep, moderately well drained soil is on hills. It formed in very compact glacial till. The vegetation in areas not cultivated is mainly conifers. Elevation is 25 to 500 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer, where mixed to a depth of 6 inches, is dark brown gravelly loam. The upper 5 inches of the subsoil is dark brown gravelly loam, and the lower 5 inches is olive brown very gravelly loam. The substratum is grayish brown very gravelly loam about 11 inches thick. Dense glacial till that crushes to very gravelly fine sandy loam is at a depth of about 27 inches. Depth to dense glacial till ranges from 18 to 36 inches.

Included in this unit are small areas of Bow soils on remnant glaciated terraces, Coveland soils in swales on hills, and Swinomish and Catla soils on ridges and hills.

Permeability of this Clallam soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A perched water table fluctuates between depths of 18 and 36 inches in January to April.

This unit is used as woodland, hayland, and pastureland.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 130. On the basis of a 50-year site curve, the mean site index for Douglas fir is 98. The highest average growth rate for Douglas fir is 130 cubic feet per acre per year at age 70. Among the trees of limited extent are western hemlock, grand fir, western redcedar, red alder, and Pacific madrone. Common forest understory plants are salal, red huckleberry, Oregongrape,. creambush oceanspray, western brackenfern, northern twinflower, and western swordfern.

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

Seedling establishment and the hazard of windthrow are the main concerns 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 periodically. High soil temperatures and the restricted available water capacity of the soil during the growing season can result in a high mortality rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas fir seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

The main limitations for hay and pasture are the hazard of erosion and droughtiness. 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. Seedbed preparation should be on the contour or across the slope where practical. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This map unit is in capability subclass IVe.

31-Clallam-Urban land complex, 0 to 8 percent slopes. This map unit is on glaciated hills. The native vegetation is mainly conifers and deciduous trees. Elevation is 25 to 150 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

This unit is about 45 percent Clallam gravelly loam and about 40 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 Bow soils on glaciated remnant terraces.

The Clallam soil is moderately deep and moderately well drained. It formed in dense glacial till. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer, where mixed to a depth of 6 inches, is dark brown gravelly loam. The upper 5 inches of the subsoil is dark brown gravelly loam, and the lower 5 inches is olive brown very gravelly loam. The substratum is grayish brown very gravelly loam about 11 inches thick. Dense glacial till that crushes to very gravelly fine sandy loam is at a depth of about 27 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some small areas the substratum is clay.

Permeability of this Clallam soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A perched water table fluctuates between depths of 18 and 36 inches from January to April.

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

The Clallam soil in this unit is used for vegetated buffer areas, lawns, and vacant lots.

If this unit is used for homesite development, the main limitations are wetness in winter and early in spring and the depth to dense glacial till. Drainage is needed if roads and building foundations are constructed. Wetness can be reduced by installing drain tile around footings. 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 depth to dense glacial till and wetness in winter. Use of interceptor drains, additional topsoil placed over the absorption field, and longer absorption lines placed on the contour helps to compensate for these limitations.

This map unit is in capability subclass IVe.

32-Clendenen gravelly silt loam, 3 to 30 percent slopes. This shallow, moderately well drained soil is on glacially modified mountainsides. It formed in colluvium containing volcanic ash and loess and is underlain by

dense glacial till. The native vegetation is mainly conifers. Elevation is 2,600 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 80 to 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 8 inches thick. The surface layer, where mixed to a depth of 7 inches, is dark reddish gray gravelly silt loam. The subsoil is dark brown and dark yellowish brown very gravelly loam 9 inches thick. Light gray, dense glacial till that crushes to very gravelly loam is at a depth of about 16 inches. Depth to dense glacial till ranges from 14 to 20 inches. In some areas the surface layer is loam or gravelly loam.

Included in this unit are small areas of Crinker and Springsteen soils on mountainsides.

Permeability of this Clendenen soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low. Effective rooting depth is 14 to 20 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the dense glacial till at a depth of 12 to 18 inches from November to June.

This unit is used as woodland and watershed.

Western hemlock and Pacific silver fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for western hemlock is 105. On the basis of a 50-year site curve, the mean site index for western hemlock is 75. The highest average growth rate for western hemlock is 151 cubic feet per acre per year at age 60. Estimates of the site index and yield of Pacific silver fir have not been made. Among the trees of limited extent are mountain hemlock and western redcedar. Common forest understory plants are tall blue huckleberry, bunchberry dogwood, trailing blackberry, western brackenfern, and deer fern.

The main limitations for the harvesting of timber are muddiness caused by soil wetness and winter snowpack. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Winter snowpack hinders the use of equipment and limits access in winter. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

The hazard of windthrow and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock and noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The perched water table reduces root respiration, which results in a low survival rate of seedlings. Because the rooting depth is restricted by the dense glacial till, trees frequently are subject to windthrow.

This map unit is in capability subclass VIe.

33-Clendenen gravelly silt loam, 30 to 65 percent slopes. This shallow, moderately well drained soil is on glacially modified mountainsides. It formed in colluvium containing volcanic ash and loess and underlain by dense glacial till. The native vegetation is mainly conifers. Elevation is 2,600 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 80 to 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 9 inches thick. The surface layer is pinkish gray gravelly silt loam 5 inches thick. The subsoil is dark reddish brown and dark brown very gravelly silt loam 11 inches thick. Light gray, dense glacial till that crushes to very gravelly loam is at a depth of about 16 inches. Depth to dense glacial till ranges from 14 to 20 inches. In some areas the surface layer is loam or gravelly loam.

Included in this unit are small areas of Crinker and Springsteen soils on mountainsides and small areas of Rock outcrop.

Permeability of this Clendenen soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low. Effective rooting depth is 14 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 12 to 18 inches from November to June.

This unit is used as woodland and watershed.

Western hemlock and Pacific silver fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for western hemlock is 105. On the basis of a 50-year site curve, the mean site index for western hemlock is 75. The highest average growth rate for western hemlock is 151 cubic feet per acre per year at age 60. Estimates of the site index and yield of Pacific silver fir have not been made. Among the trees of limited extent are mountain hemlock and western redcedar. Common forest

understory plants are tall blue huckleberry, bunchberry dogwood, trailing blackberry, western brackenfern, and deer fern.

The main limitations for the harvesting of timber are steepness of slope and winter snowpack. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Winter snowpack hinders the use of equipment and limits access in winter. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

The hazard of windthrow and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. The perched water table reduces root respiration, which results in a low survival rate of seedlings. Because the rooting depth is restricted by the dense glacial till, trees frequently are subject to windthrow.

This map unit is in capability subclass VIe.

34-Cokedale silt loam. This very deep. somewhat poorly drained soil is on flood plains. It formed in alluvium derived dominantly from phyllite. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly mixed hardwoods and conifers. Elevation is 120 to 1,200 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 51 degrees F. and the average frost-free season is 160 to 200 days.

Typically, the surface layer is dark gray silt loam 4 inches thick. The upper 23 inches of the underlying material is gray and very dark gray silt loam, the next 18 inches is dark olive gray sand, and the lower part to a depth of 60 inches or more is black, stratified very channery loamy sand with thin strata of loamy sand. Depth to sand or loamy sand ranges from 16 to 35 inches. In some areas the surface layer is loam, sandy loam, or gravelly silt loam.

Included in this unit are small areas of Wickersham soils on alluvial fans, Barneston and Skipopa soils on terraces. and Larush soils on low terraces.

Permeability of the Cokedale soil is moderate to a depth of 16 to 35 inches and very rapid below this depth. Available water capacity is moderately high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 6 to 24 inches from December to April. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, brief periods of flooding in December through March.

This unit is used mainly as woodland. It is also used as hayland. pastureland, and cropland.

Douglas fir and red alder are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 165. On the basis of a 50-year site curve, the mean site index is estimated to be 125 for Douglas fir and 95 for red alder. The highest average growth rate is 176 cubic feet per acre per year for Douglas fir at age 60 and 109 cubic feet per acre per year for red alder at age 40. Among the trees of limited extent are western redcedar, western hemlock, and bigleaf maple. Common forest understory plants are salmonberry, stinging nettle, vine maple, and western swordfern.

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

Seedling establishment and the hazard of windthrow are the main concerns 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. When openings are made in the canopy, invading brushy plants can prevent the establishment of reforestation. Trees are frequently subject to windthrow during periods when the soil is excessively wet and the winds are strong. The seasonal high water table reduces root respiration, which results in a low survival rate of seedlings.

The main limitations for hay, pasture, and cultivated crops are the seasonal high water table and the hazard of flooding. The water table limits the use of this unit to grasses and shallow-rooted legumes. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Tile drains and open drains can be used to lower the water table if a suitable outlet is available.

Adequate construction and proper maintenance of dikes reduce the hazard of flooding. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Animal manure can be properly applied on grass-legume crops periodically during the growing season.

Protecting the unit from flooding and providing drainage facilitate timely field operations and increase yields of climatically adapted cultivated crops. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, fertility, and tilth.

This map unit is in capability subclass IIIw.

35-Coveland gravelly loam, 0 to 3 percent slopes. This very deep. somewhat poorly drained soil is in swales on hills. It formed in glaciolacustrine material. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 10 to 250 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is black and dark brown gravelly loam 9 inches thick. The subsurface layer is dark grayish brown very gravelly sandy loam 5 inches thick. The subsoil is olive gray, gray, and dark gray silty clay 38 inches thick. The substratum to a depth of 60 inches or more is olive gray silty clay. In some areas the surface layer is gravelly silt loam or is thin gravelly loam and has properties associated with weathered volcanic ash, and in some areas the subsoil is loamy.

Included in this unit are small areas of Catla and Clallam soils on hills and Coveland soils that have slopes of more than 3 percent.

Permeability of this Coveland soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at the surface to a depth of 18 inches below the surface from November to April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland, hayland, and pastureland. It is also suited to climatically adapted cultivated crops.

Douglas fir and western redcedar are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 120. On the basis of a 50-year site curve. the mean site index for Douglas fir is estimated to be 95. The highest average growth rate for Douglas fir is 115 cubic feet per acre per year at age 60. Estimates of the site index and yield for western redcedar have not been made. Among the trees of limited extent are western hemlock, grand fir, and red alder. Common forest understory plants are salal, Oregongrape, trailing blackberry, rose, western swordfern, currant, and creambush oceanspray.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. When wet. unsurfaced roads and skid trails are sticky and slippery and they can be impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

The hazard of windthrow 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 periodically. The perched water table reduces root respiration, which results in a low survival rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by the perched water table and the clay layer, trees frequently are subject to windthrow.

The main limitation for hay and pasture is the perched water table. Tile drains and field ditches are needed to lower the perched water table if deep-rooted plants are grown. The water table limits the use of this unit to grasses and shallow-rooted legumes. Shallow ditches help to speed removal of surface water and to prevent ponding in winter. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This map unit is in capability subclass IIIw.

36-Coveland gravelly loam, 3 to 10 percent slopes. This very deep, somewhat poorly drained soil is in swales of hills. It formed in glaciolacustrine material. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 10 to 250 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season -is 160 to 210 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is black and dark brown gravelly loam 9 inches thick. The subsurface layer is dark grayish brown very gravelly sandy loam 5 inches thick. The subsoil is olive

gray. gray, and dark gray silty clay 38 inches thick. The substratum to a depth of 60 inches or more is olive gray silty clay. In some areas the surface layer is gravelly silt loam or is thin gravelly loam and has properties associated with weathered volcanic ash, and in some areas the subsoil is loamy.

Included in this unit are small areas of Catla and Clallam soils on hills and Coveland soils that have slopes of more than 10 percent.

Permeability of this Coveland soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at the surface to a depth of 18 inches below the surface from November to April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland, hayland, and pastureland.

Douglas fir and western redcedar are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 120. On the basis of a 50-year site curve. the mean site index for Douglas fir is estimated to be 95. The highest average growth rate for Douglas fir is 115 cubic feet per acre per year at age 60. Estimates of the site index and yield for western redcedar have not been made. Among the trees of limited extent are western hemlock, grand fir, and red alder. Common forest understory plants are salal, Oregongrape, trailing blackberry, rose, western swordfern, currant, and creambush oceanspray.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. When wet, unsurfaced roads and skid trails are sticky and slippery and they can be impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

The hazard of windthrow 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 periodically. The perched water table reduces root respiration, which results in a low survival rate of seedlings. When openings are made in the canopy. invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by the perched water table and the clay layer, trees frequently are subject to windthrow.

The main limitation for hay and pasture is the perched water table. Tile drains and field ditches are needed to lower the water table if deep-rooted plants are grown. The water table limits the use of this unit to grasses and shallow-rooted legumes. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Newly seeded areas are subject to erosion if not adequately protected. Seedbed preparation should be on the contour or across the slope where practical.

This map unit is in capability subclass IIIe.

37-Coveland-Bow complex, 0 to 5 percent slopes. This map unit is on hills. Slopes are smooth and are concave or convex. The Coveland soil is in depressional areas, and the Bow soil is on mounds. The native vegetation is mainly conifers and shrubs. Elevation is 10 to 250 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

This unit is about 50 percent Coveland gravelly loam, 0 to 3 percent slopes, and about 40 percent Bow gravelly loam, 2 to 5 percent slopes. 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 Bellingham soils in depressional areas and along drainageways and Catla and Clallam soils on knolls.

The Coveland soil is very deep and somewhat poorly drained. It formed in glaciolacustrine material. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is black and dark brown gravelly loam 9 inches thick. The subsurface layer is dark grayish brown very gravelly sandy loam 5 inches thick. The subsoil is olive gray, gray, and dark gray silty clay 38 inches thick. The substratum to a depth of 60 inches or more is olive gray silty clay. In some areas the surface layer is gravelly silt loam, and in some areas the surface layer is thin gravelly loam and has properties associated with weathered volcanic ash.

Permeability of the Coveland soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at the surface to a depth of 18 inches below the surface from November to April. Runoff is slow, and the hazard of water erosion is slight.

The Bow soil is very deep and somewhat poorly drained. It formed in gravelly glacial drift over

glaciolacustrine material mantled with volcanic ash. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown gravelly loam 5 inches thick. The upper 3 inches of the subsoil is brown gravelly loam, the next 14 inches is dark grayish brown clay loam, and the lower part to a depth of 60 inches or more is gray silty clay. In some areas the surface layer is gravelly silt loam, in some areas the surface layer is black to dark brown gravelly loam about 9 inches thick, and in some areas the subsoil is gravelly or loamy.

Permeability of the Bow soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 6 to 18 inches from November to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland, hayland, and pastureland. It is also suited to climatically adapted cultivated crops.

Douglas fir and western redcedar are the main woodland species on the Coveland soil in this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 120. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 95. The highest average growth rate for Douglas fir is 115 cubic feet per acre per year at age 60. Estimates of the site index and yield for western redcedar have not been made. Among the trees of limited extent are western hemlock, grand fir, and red alder. Common forest understory plants are salal, Oregongrape, trailing blackberry, rose, western swordfern, currant, and creambush oceanspray.

Douglas fir is the main woodland species on the Bow soil in this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 126. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 94. The highest average growth rate for Douglas fir is 122 cubic feet per acre per year at age 70. Among the trees of limited extent are western redcedar, red alder, grand fir. and western hemlock. Common forest understory plants are salal, creambush oceanspray, western swordfern, northern twinflower, evergreen huckleberry, and trailing blackberry.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. When wet, unsurfaced roads and skid trails are sticky and slippery and they can be impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

The hazard of windthrow and seedling establishment are the main concerns 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 periodically. The perched water table reduces root respiration, which results in a low survival rate of seedlings. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings on the Bow soil and delay the establishment of seedlings on the Coveland soil. Because the rooting depth is restricted by the perched water table and the clay layers, trees frequently are subject to windthrow.

Tile drains and field ditches are needed to lower the water table if deep-rooted crops are grown. Shallow ditches help to speed removal of surface water and to prevent ponding in winter. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, fertility, and filth. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition.

This map unit is in capability subclass IIIw.

38-Coveland-Bow complex, 5 to 10 percent slopes. This map unit is on hills, Slopes are smooth and are concave and convex. The Coveland soil is in depressional areas, and the Bow soil is on mounds. The native vegetation is mainly conifers and shrubs. Elevation is 10 to 250 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

This unit is about 50 percent Coveland gravelly loam, 5 to 8 percent slopes, and about 40 percent Bow gravelly loam, 5 to 10 percent slopes. 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 Bellingham soils in depressional areas and along drainageways and Catla and Clallam soils on knolls.

The Coveland soil is very deep and somewhat poorly drained. It formed in glaciolacustrine material. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is black and dark brown gravelly loam 9 inches thick. The subsurface layer is dark grayish brown very gravelly sandy loam 5 inches thick. The subsoil is olive gray, gray, and dark gray silty clay 38 inches thick. The substratum to a depth of 60 inches or more is olive gray

silty clay. In some areas the surface layer is gravelly silt loam, and in some areas the surface layer is thin gravelly loam that has properties associated with weathered volcanic ash.

Permeability of the Coveland soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at the surface to a depth of 18 inches from November to April. Runoff is slow, and the hazard of water erosion is slight.

The Bow soil is very deep and somewhat poorly drained. It formed in glacial drift over glaciolacustrine material and has a mantle of volcanic ash. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown gravelly loam 5 inches thick. The upper 3 inches of the underlying material is brown gravelly loam, the next 14 inches is dark grayish brown clay loam, and the lower part to a depth of 60 inches or more is gray silty clay. In some areas the surface layer is gravelly silt loam.

Permeability of the Bow soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 6 to 18 inches from November to May. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. hayland, and pastureland. It is also suited to climatically adapted cultivated crops.

Douglas fir and western redcedar are the main woodland species on the Coveland soil in this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 120. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 95. The highest average growth rate for Douglas fir is 115 cubic feet per acre per year at age 60. Estimates of the site index and yield for western redcedar have not been made. Among the trees of limited extent are western hemlock, grand fir, and red alder. Common forest understory plants are salal. Oregongrape, trailing blackberry, rose, western swordfern, currant, and creambush oceanspray.

Douglas fir is the main woodland species on the Bow soil in this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 126. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 94. The highest average growth rate for Douglas fir is 122 cubic feet per acre per year at age 70. Among the trees of limited extent are western redcedar, red alder., grand fir, and western hemlock. Common forest understory plants are salal, creambush oceanspray, western swordfern, northern twinflower, evergreen huckleberry, and trailing blackberry.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. When wet, unsurfaced roads and skid trails are sticky and slippery and they can be impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

The hazard of windthrow and seedling establishment are the main concerns 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 periodically. The perched water table reduces root respiration, which results in a low survival rate of seedlings. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings on the Bow soil and delay the establishment of seedlings on the Coveland soil. Because the rooting depth is restricted by the perched water table, trees frequently are subject to windthrow.

If climatically adapted cultivated crops are grown on this unit, tile drains and field ditches are needed to lower the perched water table and adequate erosion control practices such as use of crop residue and conservation tillage should be used. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion.

This map unit is in capability subclass IIIw.

39-Crinker-Rock outcrop complex, 3 to 30 percent slopes. This map unit is on glaciated mountain ridgetops. The native vegetation is mainly conifers. Elevation is 2,800 to 4,000 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 90 to 110 days.

This unit is about 60 percent Crinker very channery silt loam and about 20 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 soils that are more than 40 inches or less than 20 inches deep to phyllite.

The Crinker soil is moderately deep and well drained. It formed in volcanic ash, glacial till, and colluvium derived dominantly from phyllite. Typically, the surface is covered with a mat of leaves, needles, and twigs 3 inches thick. The surface layer, where mixed to a depth

of 4 inches, is grayish brown very channery silt loam. The upper 5 inches of the subsoil is yellowish brown very channery silt loam, and the lower 11 inches is yellowish brown very channery loam. The substratum is light yellowish brown extremely channery loam about 12 inches thick. Phyllite is at a depth of about 32 inches. Depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is gravelly loam or very gravelly silt loam, and in some areas dense glacial till is at a depth of 20 to 40 inches.

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

Rock outcrop consists of exposures of hard and mostly unweathered phyllite. It occurs as steep cliffs and irregular formations.

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 for western hemlock is 119. On the basis of a 50-year site curve, the mean site index for western hemlock is 83. The highest average growth rate for western hemlock is 178 cubic feet per acre per year at age 50. The areas of Rock outcrop make up about 20 percent of this unit and limit yields accordingly. Among the trees of limited extent is Pacific silver fir. Common forest understory plants are tall blue huckleberry, salmonberry, bunchberry dogwood, western brackenfern, deer fern, and queencup beadlily.

The main limitations for the harvesting of timber are the areas of Rock outcrop and winter snowpack. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft and slippery when wet. Logging roads require suitable surfacing for year-round use. Material cast to the side ravels and commonly sloughs when saturated. Rock for road construction is not readily available on this unit. Areas of Rock outcrop hinder harvesting operations. Snowpack hinders the use of equipment and limits access in winter. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Cutbanks may slump when the soil is saturated.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The droughtiness of the surface layer reduces the survival rate of seedlings. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. Where openings are made in the canopy, invading brushy plants can delay the establishment of the seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong. The areas of Rock outcrop limit the even distribution of reforestation.

This map unit is in capability subclass VIe.

40-Crinker-Rock outcrop complex, 30 to 65 percent slopes. This map unit is on glacially modified mountains. The native vegetation is mainly conifers. Elevation is 2,800 to 4,000 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 90 to 110 days.

This unit is about 65 percent Crinker very channery silt loam and about 25 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 soils that are more than 40 inches or less than 20 inches deep to phyllite.

The Crinker soil is moderately deep and well drained. It formed in volcanic ash, glacial till, and colluvium derived dominantly from phyllite. Typically, the surface is covered with a mat of leaves, needles, and twigs 5 inches thick. The surface layer, where mixed to a depth of 6 inches, is grayish brown very channery silt loam. The subsoil is dark yellowish brown and yellowish red very channery silt loam 8 inches thick. The substratum is olive extremely channery loam about 8 inches thick. Phyllite is at a depth of about 22 inches. Depth to phyllite ranges from 20 to 40 inches. In some areas dense glacial till is at a depth of 20 to 40 inches.

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

Rock outcrop consists of exposures of hard and mostly unweathered phyllite. It occurs as steep cliffs and irregular formations.

This unit is used as woodland and watershed.

Western hemlock is the main woodland species on the Crinker soil. On the basis of a 100-year site curve, the mean site index for western hemlock is 119. On the basis of a 50-year site curve, the mean site index for western hemlock is 83. The highest average growth rate for western hemlock is 178 cubic feet per acre per year at age 50. The areas of Rock outcrop make up about 25 percent of this unit and reduce yields accordingly.

Among the trees of limited extent is Pacific silver fir. Common forest understory plants are tall blue huckleberry, salmonberry. bunchberry dogwood, western brackenfern, deer fern, and queencup beadlily.

The main limitations for the harvesting of timber are steepness of slope, the areas of Rock outcrop, and winter snowpack. Cable yarding systems generally are used on this unit. Unsurfaced roads and skid trails are soft and slippery when wet. Logging roads require suitable surfacing for year-round use. Material cast to the side ravels and commonly sloughs when saturated. Rock for road construction is not readily available on this unit. Winter snowpack hinders the use of equipment and limits access in winter. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Cutbanks may slump when the soil is saturated.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock and noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The droughtiness of the surface layer reduces the survival rate of seedlings. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. When openings are made in the canopy, invading brushy plants can delay the establishment of the seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong. The areas of Rock outcrop limit the even distribution of reforestation.

This map unit is in capability subclass VIIe.

41-Cupples gravelly silt loam, 3 to 30 percent slopes. This moderately deep. moderately well drained soil is on glaciated hills and mountainsides. It formed in volcanic ash and glacial till. The native vegetation is mainly conifers. Elevation is 1,000 to 2,000 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 110 to 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer, where mixed to a depth of 5 inches, is dark brown gravelly silt loam. The upper 13 inches of the subsoil is strong brown very gravelly loam, and the lower 16 inches is dark yellowish brown very gravelly sandy loam. Dark grayish brown, dense glacial till that crushes to very gravelly sandy loam is at a depth of about 34 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some small areas the profile is less than 35 percent coarse fragments.

Included in this unit are small areas of Skykomish soils on terraces and deep soils that have a less developed subsoil and are on mountainsides.

Permeability of this Cupples soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is limited by a perched water table that is at a depth of 18 to 36 inches from December to April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock and Douglas fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 143 for western hemlock and 154 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 102 for western hemlock and 118 for Douglas fir. The highest average growth rate is 224 cubic feet per acre per year for western hemlock at age 50 and 163 cubic feet per acre per year for Douglas fir at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent is western redcedar. Common forest understory plants are western swordfern, deer fern, red huckleberry, northern twinflower, salmonberry, and vine maple.

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

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock and 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 rate of seedlings. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass IVe.

42-Cupples gravelly silt loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is on glaciated mountains. It formed in volcanic ash and glacial till. The native vegetation is mainly conifers. Elevation is 1,000 to 2,000 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 110 to 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 7 inches thick. The surface layer, where mixed to a depth of 8 inches, is dark brown gravelly silt loam. The upper 10 inches of the subsoil is strong brown very gravelly loam, and the lower 16 inches is dark yellowish brown very gravelly sandy loam. Dark grayish brown, dense glacial till that crushes to very gravelly sandy loam is at a depth of about 34 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some small areas the profile is less than 35 percent coarse fragments.

Included in this unit are small areas of Skykomish soils on outwash terraces and deep soils that have a less developed subsoil and are on mountainsides.

Permeability of this Cupples soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is limited by a perched water table that is at a depth of 18 to 36 inches from December to April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock and Douglas fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 143 for western hemlock and 154 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 102 for western hemlock and 118 for Douglas fir. The highest average growth rate is 224 cubic feet per acre per year for western hemlock at age 50 and 163 cubic feet per acre per year for Douglas fir at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent is western redcedar. Common forest understory plants are western swordfern, deer fern, red huckleberry. northern twinflower, salmonberry, and vine maple.

The main limitation for the harvesting of timber is steepness of slope. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft during wet periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Occasional snowpack hinders the use of equipment and limits access in winter. Cutbanks may slump when the soil is saturated.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock and 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 rate of seedlings. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass Vle.

43-Diobsud gravelly silt loam, 3 to 30 percent slopes. This moderately deep, moderately well drained soil is on glacially modified mountains. It formed in volcanic ash and glacial till derived dominantly from phyllite. The native vegetation is mainly conifers. Elevation is 2,800 to 4,200 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 38 degrees F, and the average frost-free season is 90 to 110 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 10 inches thick. The surface layer, where mixed to a depth of 6 inches, is strong brown gravelly silt loam. The upper 8 inches of the subsoil is strong brown gravelly loam, and the lower 10 inches is dark brown gravelly loam. The substratum is gray gravelly loam about 4 inches thick. Dense phyllitic glacial till is at a depth of about 28 inches. Depth to dense phyllitic glacial till ranges from 20 to 40 inches. In some areas the soil is more than 35 percent rock fragments and does not have properties associated with weathered volcanic ash.

Included in this unit are small areas of Rock outcrop and deep soils that have a less developed subsoil and are on mountainsides.

Permeability of this Diobsud soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is limited by a 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 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 for western hemlock is 105. On the basis of a 50-year site curve, the mean site index for western hemlock is 75. The highest average growth rate for western hemlock is 151 cubic feet per acre per year at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent are Pacific silver fir, western redcedar, and mountain hemlock. Common forest understory plants are bunchberry dogwood, queencup beadlily, and tall blue huckleberry.

The main limitations for the harvesting of timber are winter snowpack and muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft and slippery when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Winter snowpack hinders the use of equipment and limits access in winter. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock and noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by Pacific silver fir occurs periodically. Low soil temperature in summer, deep winter snowpack, and a short growing season reduce the survival rate of planted and natural seedlings and delay their establishment. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. Seedlings planted in the less fertile subsoil exhibit poor growth and vigor. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass Vle.

44-Diobsud gravelly silt loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is on glacially modified mountains. It formed in volcanic ash and glacial till derived dominantly from phyllite. The native vegetation is mainly conifers. Elevation is 2,800 to 4,200 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 38 degrees F, and the average frost-free season is 90 to 110 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 9 inches thick. The surface layer. where mixed to a depth of 7 inches, is grayish brown gravelly silt loam. The upper 6 inches of the subsoil is yellowish red gravelly silt loam, and the lower 8 inches is olive gravelly loam. The substratum is gray gravelly loam about 7 inches thick. Pale olive, dense glacial till that crushes to gravelly loam is at a depth of about 28 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the profile is more than 35 percent rock fragments, and in some areas the substratum is sandy loam. In some areas the subsoil does not have dark organic stains. and in some areas the soil does not have properties associated with weathered volcanic ash.

Included in this unit are some areas of deep soils and small areas of Rock outcrop.

Permeability of this Diobsud soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is limited by a 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 as woodland and watershed.

Western hemlock is the main woodland species on this unit. On the basis of the 100-year site curve, the mean site index for western hemlock is 105. On the basis of a 50-year site curve, the mean site index for western hemlock is 75. The highest average growth rate for western hemlock is 151 cubic feet per acre per year at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent are Pacific silver fir, western redcedar, and mountain hemlock. Common forest understory plants are bunchberry dogwood, queencup beadlily, and tall blue huckleberry.

The main limitation for the harvesting of timber is steepness of slope. 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 and slippery when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Winter snowpack hinders the use of equipment and limits access in winter. Cutbanks may slump when the soil is saturated. Harvesting systems that lift logs

entirely off the ground reduce the disturbance of the protective layer of duff.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present. natural reforestation of cutover areas by Pacific silver fir occurs periodically. Low soil temperature in summer, deep winter snowpack, and a short growing season reduce the survival rate of planted and natural seedlings and delay their establishment. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. Seedlings planted in the less fertile subsoil exhibit poor growth and vigor. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIe.

45-Diobsud-Crinker complex, 30 to 65 percent slopes. This map unit is on glaciated mountains. The native vegetation is mainly conifers. Elevation is 2,800 to 4,200 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 38 degrees F. and the average frost-free season is 90 to 110 days.

This unit is about 70 percent Diobsud gravelly silt loam and about 20 percent Crinker very channery 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 some areas of deep soils and small areas of Rock outcrop.

The Diobsud soil is moderately deep and moderately well drained. It formed in volcanic ash and glacial till derived dominantly from phyllite. Typically, the surface is covered with a mat of needles, leaves, and twigs 9 inches thick. The surface layer, where mixed to a depth of 7 inches, is grayish brown gravelly silt loam. The upper 6 inches of the subsoil is yellowish red gravelly silt loam, and the lower 8 inches is olive gravelly loam. The substratum is gray gravelly loam about 7 inches thick. Pale olive, dense glacial till that crushes to gravelly loam is at a depth of about 28 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the soil is more than 35 percent rock fragments, does not have dark organic stains in the subsoil, and does not have properties associated with weathered volcanic ash.

Permeability of the Diobsud soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is limited by a 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 Crinker soil is moderately deep and well drained. It formed in volcanic ash and colluvium derived dominantly from phyllite. Typically, the surface is covered with a mat of leaves, needles, and twigs 3 inches thick. The surface layer, where mixed to a depth of 4 inches, is grayish brown very channery silt loam. The upper 5 inches of the subsoil is yellowish brown very channery silt loam, and the lower 11 inches is yellowish brown very channery loam. The substratum is light yellowish brown extremely channery loam about 12 inches thick. Phyllite is at a depth of about 32 inches. Depth to phyllite ranges from 20 to 40 inches. In some areas the subsoil has rounded fragments, and in some areas the subsoil does not have organic stains.

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

This unit is used as woodland and watershed.

Western hemlock is the main woodland species on the Diobsud soil. On the basis of a 100-year site curve, the mean site index for western hemlock is 105. On the basis of a 50-year site curve, the mean site index for western hemlock is 75. The highest average growth rate for western hemlock is 151 cubic feet per acre per year at age 60. Among the trees of limited extent are Pacific silver fir, western redcedar, and mountain hemlock. Common forest understory plants are bunchberry dogwood, queencup beadlily, and tall blue huckleberry.

Western hemlock is the main woodland species on the Crinker soil. On the basis of a 100-year site curve, the mean site index for western hemlock is 119. On the basis of a 50-year site curve, the mean site index for western hemlock is 83. The highest average growth rate for western hemlock is 178 cubic feet per acre per year at age 50. Among the trees of limited extent is Pacific silver fir. Common forest understory plants are tall blue huckleberry, salmonberry, bunchberry dogwood, western brackenfern, deer fern, and queencup beadlily.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. Cutbanks may slump when the soil is saturated. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees.

Unsurfaced roads and skid trails are soft and slippery when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Winter snowpack limits the use of equipment and restricts access.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock and noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by Pacific silver fir occurs periodically. The droughtiness of the surface layer reduces the survival rate of seedlings. Low soil temperature in summer, deep winter snowpack. and a short growing season reduce the survival rate of planted and natural seedlings and delay their establishment. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings on the Crinker soil. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass Vle.

46-Dystric Xerochrepts, 45 to 70 percent slopes. These moderately deep to very deep, well drained soils are on escarpments. They formed in glacial till and colluvium derived from rocks of mixed mineralogy. The native vegetation is mainly conifers and mixed hardwoods. Elevation is 50 to 1,300 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of needles, leaves, and twigs about 1 inch thick. The surface layer is dark brown gravelly loam 4 inches thick. The subsoil is dark brown and dark yellowish brown very gravelly loam and very gravelly sandy loam 39 inches thick. The substratum to a depth of 60 inches or more is light olive brown very gravelly sandy loam. Texture, the content of rock fragments. and depth to dense glacial till vary widely within short distances. In some small areas these soils have a clayey or sandy subsoil and substratum.

Included in this unit are small areas of Tokul soils on hills and Barneston and Indianola soils on terraces.

Permeability of these Dystric Xerochrepts is moderate. Available water capacity is very low to moderate. Effective rooting depth is 20 to 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 species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 166. On the basis of a 50-year site curve, the mean site index for Douglas fir is 128. The highest average growth rate for Douglas fir is 177 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Common forest understory plants are salal. Oregongrape, western swordfern, red huckleberry, western brackenfern, trailing blackberry, and salmonberry.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. 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. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Following road construction and clearcutting. road failures and landslides are likely to occur.

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 red alder occurs readily. The droughtiness of the surface layer reduces the survival rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of Douglas fir seedlings.

This map unit is in capability subclass Vlle.

47-Dystric Xerochrepts, 70 to 90 percent slopes. These moderately deep to very deep, well drained soils are on mountainsides. They formed in glacial till and colluvium derived from serpentine. The native vegetation is mainly conifers. Elevation is near sea level to 1,500 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 190 to 210 days.

No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of needles, leaves, and twigs about 2 inches thick. The surface layer is dark brown very gravelly

loam 4 inches thick. The subsoil is reddish brown very gravelly clay loam 12 inches thick. The substratum is dark grayish brown extremely gravelly loam about 30 inches thick. Serpentine is at a depth of about 46 inches. Depth to serpentine ranges from 20 to 60 inches or more. Texture. the content of rock fragments, and depth to bedrock or dense glacial till vary widely within short distances.

Included in this unit are small areas of Rock outcrop.

Permeability of these Dystric Xerochrepts is moderate. Available water capacity is low to moderate. Effective rooting depth is 20 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

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 for Douglas fir is estimated to be 105. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 80. The highest average growth rate for Douglas fir is 91 cubic feet per acre per year at age 60. Among the trees of limited extent are grand fir and western redcedar. Common forest understory plants are salal, Oregongrape, western swordfern, red huckleberry, western brackenfern, Pacific madrone, rose, and rhododendron.

The main limitation for the harvesting of timber is steepness of slope. Cable yarding systems generally are used on this unit. Unsurfaced roads and skid trails are slippery when wet. Logging roads require suitable surfacing for year-round use. Material cast to the side ravels and commonly sloughs when saturated. Rock for road construction is readily available on this unit. Establishing plant cover on steep cuts and fills reduces erosion.

Seedling establishment and the hazard of windthrow are the main concerns 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 grand fir occurs periodically. The droughtiness of the surface layer increases the mortality rate of seedlings, especially on south- and southwest-facing side slopes. Trees on this unit exhibit poor growth and vigor because of the high content of magnesium in proportion to the content of calcium. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIIe.

48-Dystric Xerochrepts-Rock outcrop complex, 65 to 90 percent slopes. This map unit is on dip slopes in mountainous areas. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 300 to 1,600 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 170 to 190 days.

This unit is about 60 percent Dystric Xerochrepts and about 30 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.

Dystric Xerochrepts are moderately deep to deep and are well drained. They formed in colluvium derived dominantly from glacial till and sandstone. No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of needles, leaves, and twigs about 1 inch thick. The surface layer is black very gravelly silt loam 2 inches thick. The subsoil is dark brown and dark yellowish brown very gravelly loam 37 inches thick. The substratum is dark brown very gravelly loam 6 inches thick. Sandstone is at a depth of 45 inches. Depth to sandstone ranges from 20 to 60 inches or more. In some areas dense glacial till is at a depth of 20 to 40 inches.

Permeability of these Dystric Xerochrepts is moderate. Available water capacity is low to moderately high. Effective rooting depth is 20 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of hard and mostly unweathered sandstone. It occurs as steep cliffs and irregular formations.

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 for Douglas fir is 156. On the basis of a 50-year site curve, the mean site index for Douglas fir is 120. The highest average growth rate for Douglas fir is 165 cubic feet per acre per year at age 60. The areas of Rock outcrop make up about 30 percent of this unit and limit yields accordingly. Among the trees of limited extent are grand fir and western redcedar. Common forest understory plants are salal, Oregongrape, western brackenfern, Pacific madrone, rose, and rhododendron.

The main limitations for the harvesting of timber are steepness of slope and the 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 soil less.

Logging roads require suitable surfacing for year-round use. Material cast to the side ravels and commonly sloughs when saturated. Rock for road construction is readily available on this unit. Areas of Rock outcrop car cause breakage of timber when felled and hinder yarding. Avoiding large areas of Rock outcrop forces yarding paths to converge, which results in compaction of the soil. Establishing plant cover on steep cuts and fills 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 rifling and gullying unless they are protected by plant cover or adequate water bars are provided.

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 grand fir occurs periodically. The droughtiness of the surface layer increases the mortality rate of seedlings, especially on south- and southwest-facing side slopes. The areas of Rock outcrop limit the even distribution of reforestation. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIIe.

49-Dystric Xerorthents, 0 to 5 percent slopes. These very deep, excessively drained soils are on flood plains. They formed in recent river alluvium. The native vegetation is mainly mixed hardwoods and conifers. Elevation is 1,000 to 1,800 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 140 days.

No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of needles, leaves, and twigs about 1 inch thick. The surface layer is white and olive gravelly coarse sand 8 inches thick. The underlying material to a depth of 60 inches or more is white and pale olive, stratified extremely gravelly coarse sand to fine sandy loam.

Included in this unit are small areas of Skykomish soils on outwash terraces, Saxon soils on lacustrine terraces. and Cupples soils on low mountains. Also included are small areas of silty soils in meander channels.

Permeability of these Dystric Xerorthents is moderately rapid to very rapid. Available water capacity is low to moderate. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 36 inches from December to May, when the water level of the river is high. Runoff is slow, and the hazard of water erosion is slight. These soils are subject to frequent, brief periods of flooding from December to May.

This unit is used as woodland and wildlife habitat.

Western hemlock and western redcedar are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 135. On the basis of a 50-year site curve, the mean site index for western hemlock is estimated to be 95. The highest average growth rate for western hemlock is 209 cubic feet per acre per year at age 50. Estimates of the site index and yield for western redcedar have not been made. Among the trees of limited extent are Douglas fir, black cottonwood, and red alder. Common forest understory plants are waterhemlock, horsetail, stinging nettle, and salmonberry.

The main limitation for the harvesting of timber is frequent, brief periods of flooding. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Seasonal soil wetness and flooding limit the use of equipment to dry periods.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. Seedlings planted in the less fertile subsoil exhibit poor growth and vigor. The survival rate of seedlings may be low in areas where flooding occurs. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong. Restricted available water capacity of the soil during the growing season results in a high mortality rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIIw.

50-Dystric Xerorthents, 50 to 80 percent slopes. These very deep, excessively drained soils are on dissected outwash terrace escarpments. They formed in stratified glacial outwash. The native vegetation is mainly conifers. Elevation is 400 to 1,000 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 190 days.

No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of needles, leaves, and twigs about 1 inch thick. The surface layer is dark brown gravelly sandy

loam 7 inches thick. The subsoil is grayish brown gravelly loamy sand 3 inches thick. The substratum to a depth of 60 inches or more is stratified, dark gray very gravelly sand and gravelly sand. In some areas the surface layer is loam or sandy loam.

Included in this unit are small areas of Barneston, Giles. Gilligan, and Indianola soils on outwash terraces.

Permeability of these Dystric Xerorthents 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 severe.

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 for Douglas fir is 150. On the basis of a 50-year site curve, the mean site index for Douglas fir is 117. The highest average growth rate for Douglas fir is 158 cubic feet per acre per year at age 60. Among the trees of limited extent are western redcedar and western hemlock. Common forest understory plants are salal, western swordfern, western brackenfern, trillium, Oregongrape, and red huckleberry.

The main limitation for the harvesting of timber is steepness of slope. Cable yarding systems generally are used on this unit. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by plant cover or adequate water bars are provided. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas fir seedlings. The droughtiness of the surface layer increases the mortality rate of seedlings, especially on south- and southwest-facing side slopes. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIIe.

51-Dystric Xerorthents, cool, 60 to 90 percent slopes. These very deep, moderately well drained to somewhat excessively drained soils are on dissected and slumped lakebed terrace escarpments. They formed in lacustrine and glaciofluvial material. The native vegetation is mainly conifers. Elevation is 1,100 to 2,100 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 140 days.

No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of needles, leaves, and twigs about 2 inches thick. The surface layer is gray loam 6 inches thick. The subsoil is gray gravelly fine sandy loam 31 inches thick. The substratum to a depth of 60 inches or more is light gray clay loam. Because the water-deposited sediment in this unit is stratified, erosion may expose layers that have a wide range in texture.

Included in this unit are small areas of Jug and Skykomish soils on outwash terraces and Cupples soils on low mountains.

Permeability of these Dystric Xerorthents is moderate to a depth of 6 inches and slow to moderately slow below this depth. Available water capacity is low to high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

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 for western hemlock is estimated to be 135. On the basis of a 50-year site curve, the mean site index for western hemlock is estimated to be 100. The highest average growth rate for western hemlock is 209 cubic feet per acre per year at age 50. Among the trees of limited extent are Douglas fir and red alder. Common forest understory plants are horsetail, common beargrass, thimbleberry, and deer fern.

The main limitation for the harvesting of timber is steepness of slope. Cable yarding systems generally are used on this unit. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Cutbanks may slump when the soil is saturated. Following road construction and clearcutting, road failures and landslides are likely to occur. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. Seedlings planted in the less fertile subsoil

exhibit poor growth and vigor. When openings are made in the canopy. invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIIe.

52-Elwell gravelly silt loam, 3 to 30 percent slopes. This moderately deep. moderately well drained soil is on glaciated mountainsides. It formed in volcanic ash and glacial till. The native vegetation is mainly conifers. Elevation is 1,000 to 2,000 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 120 to 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly silt loam 2 inches thick. The subsoil is dark brown and dark yellowish brown gravelly silt loam 29 inches thick. Below this is a pale olive, weakly cemented hardpan that crushes to very gravelly loam. Depth to the hardpan ranges from 20 to 40 inches. In some areas the soil does not have a hardpan, bedrock is at a depth of 20 to 40 inches, or the soil is more than 35 percent rock fragments.

Included in this unit are small areas of Getchel soils on high mountains and small areas of Rock outcrop.

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

This unit is used as woodland.

Western hemlock and Douglas fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 149 for western hemlock and 165 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 105 for western hemlock and 124 for Douglas fir. The highest average growth rate is 236 cubic feet per acre per year for western hemlock at age 50 and 176 cubic feet per acre per year for Douglas fir at age 60. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Common forest understory plants are western swordfern, red huckleberry, western brackenfern, deer fern, salal, and Oregongrape.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts. compacts the soil. and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and red alder occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by the hardpan, trees occasionally are subject to windthrow.

This map unit is in capability subclass IVe.

53-Elwell-Rinker complex, 30 to 60 percent slopes. This map unit is on glaciated mountainsides. The native vegetation is mainly conifers. Elevation is 1,000 to 2,000 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 120 to 160 days.

This unit is about 60 percent Elwell gravelly silt loam and about 30 percent Rinker very channery 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 some areas of deep soils and small areas of Rock outcrop on mountainsides.

The Elwell soil is moderately deep and moderately well drained. It formed in volcanic ash, loess, and glacial till derived dominantly from rock of mixed mineralogy. Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly silt loam 2 inches thick. The subsoil is dark brown and dark yellowish brown gravelly silt loam 29 inches thick. Below this is a pale olive, weakly cemented hardpan that crushes to very gravelly loam. Depth to the hardpan ranges from 20 to 40 inches. In some areas the soil has phyllite fragments in the surface layer and subsoil and in the hardpan.

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

The Rinker soil is moderately deep and well drained. It formed in volcanic ash, glacial till, and colluvium derived dominantly from phyllite. Typically, the surface

is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer, where mixed to a depth of 7 inches, is brown very channery loam. The subsoil is dark yellowish brown very channery loam 11 inches thick. The substratum is light yellowish brown extremely channery silt loam about 11 inches thick. Fractured phyllite is at a depth of about 29 inches. Depth to fractured phyllite ranges from 20 to 40 inches. In some areas fractured argillite is at a depth of 20 to 40 inches.

Permeability of this Rinker soil is moderate. Available water capacity is low to moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock and Douglas fir are the main woodland species on the Elwell soil in this unit, On the basis of a 100-year site curve. the mean site index is 149 for western hemlock and 165 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 105 for western hemlock and 124 for Douglas fir. The highest average growth rate is 236 cubic feet per acre per year for western hemlock at age 50 and 176 cubic feet per acre per year for Douglas fir at age 60. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Common forest understory plants are western swordfern, red huckleberry, western brackenfern, deer fern, salal, and Oregongrape.

Western hemlock and Douglas fir are the main woodland species on the Rinker soil in this unit. On the basis of a 100-year site curve, the mean site index is 157 for western hemlock and 146 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 110 for western hemlock and 107 for Douglas fir. The highest average growth rate is 249 cubic feet per acre per year for western hemlock at age 50 and 153 cubic feet per acre per year for Douglas fir at age 60. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Common forest understory plants are salal, Oregongrape, western swordfern, western brackenfern, and vine maple.

The main limitation for the harvesting of timber is steepness of slope. Steepness of slope restricts the use of wheeled and tracked equipment in skidding operations. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Cable yarding systems generally are safer and disturb the soil less. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock and Douglas fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs periodically. Reforestation by red alder occurs periodically on the Elwell soil. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by the hardpan and bedrock, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIe.

54-Etach very gravelly sandy loam, 30 to 65 percent slopes. This moderately deep, somewhat excessively drained soil is on glacially modified mountainsides. It formed in volcanic ash and glacial till. The native vegetation is mainly conifers. Elevation is 800 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 110 to 140 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer is dark brown very gravelly sandy loam 8 inches thick. The subsoil is dark yellowish brown and brown very gravelly sandy loam 8 inches thick. The substratum is light olive brown very cobbly coarse sand about 20 inches thick. Dark yellowish brown, dense glacial till that crushes to very cobbly coarse sand is at a depth of about 36 inches. Depth to dense glacial till ranges from 26 to 40 inches. In some areas the soil has properties associated with weathered volcanic ash, and in some areas the soil has an unconsolidated substratum.

Included in this unit are small areas of deep soils, Marblemount soils, and Rock outcrop on mountainsides.

Permeability of this Etach soil is rapid above the dense glacial till and very slow through the till. Available water capacity is very low to low. Effective rooting depth is 26 to 40 inches. 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 for western hemlock is estimated to be 111. On the basis of a 50-year site curve, the mean site index for western hemlock is estimated to be 79. The

highest average growth rate for western hemlock is 162 cubic feet per acre per year at age 50. Among the trees of limited extent are Douglas fir and western redcedar. Common forest understory plants are western swordfern, salal, Pacific trillium, Oregongrape, red huckleberry, northern twinflower, and maidenhair.

The main limitation for the harvesting of timber is steepness of slope. 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. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. The droughtiness of the surface layer and low content of moisture in the soil during the growing season increase the mortality rate of seedlings, especially on south- and southwest-facing side slopes. Seedlings planted in the less fertile subsoil exhibit poor growth and vigor. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIe.

55-Fidalgo-Lithic Xerochrepts-Rock outcrop complex, 3 to 30 percent slopes. This map unit is on hills. Slopes are complex. Areas are irregular in shape and are 20 to 80 acres in size. The native vegetation is mainly conifers and shrubs. Elevation is 20 to 1,300 feet. The average annual precipitation is about 20 inches. the average annual air temperature is about 50 degrees F. and the average frost-free season is 160 to 210 days.

This unit is about 45 percent Fidalgo gravelly loam, 20 percent Lithic Xerochrepts, and 20 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 deep soils and Catla soils on hillsides.

The Fidalgo soil is moderately deep and moderately well drained. It formed in colluvium, glacial till, and an admixture of volcanic ash and residuum derived dominantly from argillite. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is very dark brown gravelly loam 3 inches thick. The upper 15 inches of the subsoil is dark brown very gravelly fine sandy loam, and the lower 7 inches is dark brown very gravelly sandy loam. The substratum is very dark brown extremely gravelly loamy sand 4 inches thick. Hard argillite is at a depth of 29 inches. Depth to argillite ranges from 20 to 40 inches. In some areas dense glacial till is at a depth of 20 to 40 inches.

Permeability of the Fidalgo soil is moderate. Available water capacity is low to moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A perched water table fluctuates between depths of 24 and 36 inches from December to March.

The Lithic Xerochrepts are shallow and moderately well drained. They formed in glacial till and residuum derived dominantly from argillite. No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of needles, leaves, and twigs about 1 inch thick. The surface layer is very dark brown gravelly loam 2 inches thick. The subsoil is brown gravelly loam 14 inches thick. Argillite is at a depth of 16 inches. Depth to argillite ranges from 10 to 20 inches. In some small areas argillite is at a depth of less than 10 inches.

Permeability of these Lithic Xerochrepts is moderate. Available water capacity is very low to low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate.

Rock outcrop consists of exposures of hard and mostly unweathered argillite. It occurs as steep cliffs and irregular formations.

This unit is used as woodland.

Douglas fir is the main woodland species on the Fidalgo soil in this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 100. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 75. The highest average growth rate for Douglas fir is 84 cubic feet per acre per year at age 60. Among the trees of limited extent are western redcedar, lodgepole pine, western hemlock, and grand fir. Common forest understory plants are Pacific madrone, Oregongrape, trailing blackberry, rose, broadleaf starflower, creambush oceanspray, sticky currant, and Indian plum.

Douglas fir is the main woodland species on the Lithic Xerochrepts in this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 85. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 65. The highest average growth rate for Douglas fir is 64 cubic feet per acre per year at age 70. Among the trees of limited extent are western redcedar, western hemlock. lodgepole pine, and grand fir.

Common forest understory plants are trailing blackberry, rose, salal, Oregongrape, and Pacific madrone.

The areas of Rock outcrop make up about 20 percent of this unit and limit yields accordingly.

The main limitations for the harvesting of timber are the areas of Rock outcrop and muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Rock outcrop hinders harvesting operations. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Seedling establishment and the hazard of windthrow are the main concerns for the production of timber. Reforestation can be accomplished by planting Douglas fir seedlings. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. The low content of moisture in the soil and droughtiness of the surface layer during the growing season result in a high mortality rate of seedlings. The areas of Rock outcrop limit the even distribution of reforestation. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by the underlying bedrock, trees occasionally are subject to windthrow on the Fidalgo soil and are frequently subject to windthrow on the Lithic Xerochrepts. If seed trees are present, natural reforestation of cutover areas by grand fir occurs periodically on the Fidalgo soil and natural reforestation by lodgepole pine occurs periodically on the Lithic Xerochrepts.

This map unit is in capability subclass VIIe.

56-Field silt loam. This very deep, moderately well drained soil is on flood plains. It formed in recent alluvium with an admixture of volcanic ash. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 10 to 50 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 220 days.

Typically, the surface layer is dark brown silt loam 13 inches thick. The upper 8 inches of the underlying material is olive silt loam, the next 19 inches is grayish brown and dark gray, stratified fine sand and loamy fine sand, and the lower part to a depth of 60 inches or more is gray and dark gray, stratified fine sand and very fine sandy loam. In some areas the surface layer is fine sandy loam, in some areas the underlying material is loamy, and in some areas the surface layer is more than 20 inches thick.

Included in this unit are small areas of Skagit and Sumas soils in depressional areas of flood plains.

Permeability of this Field soil is moderate. 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. The water table has been lowered by drainage of adjacent lowland areas. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to frequent, brief periods of flooding from November to March.

This unit is used as cropland, hayland, and pastureland.

The main limitations of this unit for use as cropland are the hazard of flooding and seasonal soil wetness. Flooding can be controlled by use of dikes. Providing drainage permits field operations to be conducted earlier and increases yields of perennial crops. If drained and protected from flooding, this unit is suited to all crops commonly grown in the survey area. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, fertility, and tilth. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Subsoiling and using minimum tillage help to prevent development of a plowpan.

Common forage plants on this unit are perennial grasses, legumes, oats, and corn. Applying animal manure on grass-legume crops periodically during the growing season helps to maintain organic matter content, fertility, and tilth. Heavy applications tend to smother grass-legume crops unless the manure crust is broken by harrowing. Use of proper stocking rates, pasture rotation. and restricted grazing during wet periods helps to keep the pasture in good condition.

This unit has potential for use as woodland. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 160. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 120. The potential highest average growth rate for Douglas fir is 170 cubic feet per acre per year at age 65. Trees of limited extent include western redcedar. Common forest understory plants are western swordfern, creambush oceanspray, red huckleberry, and trailing blackberry.

This map unit is in capability subclass IIIw.

57-Field silt loam, protected. This very deep, moderately well drained soil is on flood plains. Most areas of this soil are partially protected from flooding. The soil formed in recent alluvium with an admixture of volcanic ash. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 10 to 50 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 220 days.

Typically, the surface layer is dark brown silt loam 13 inches thick. The upper 8 inches of the underlying material is olive silt loam, the next 19 inches is grayish brown and dark gray, stratified fine sand and loamy fine sand. and the lower part to a depth of 60 inches or more is gray and dark gray, stratified very fine sandy loam and fine sand. In some areas the surface layer is fine sandy loam, in some areas the underlying material is loamy, and in some areas the surface layer is thick.

Included in this unit are small areas of Skagit and Sumas soils in depressional areas of flood plains.

Permeability of this Field soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 36 to 48 inches from November to May. The water table has been lowered by drainage of adjacent lowland areas. Runoff is slow, and the hazard of water erosion is slight. Flooding is rare in areas protected by dikes.

This unit is used as cropland, hayland, and pastureland.

This unit is suited to use as cropland. Areas of the unit that are drained are suited to all crops commonly grown in the survey area. Drainage permits field operations earlier in spring and increases yields of perennial crops. Crusting of the surface and compaction of the soil can be reduced by returning crop residue to the soil and by using minimum tillage.

Common forage plants on this soil are perennial grasses. legumes, oats, and corn. Applying animal manure helps to maintain organic matter content, fertility, and tilth. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Use of proper stocking rates, pasture rotation, and restricted grazing during the wet periods helps to keep the pasture in good condition and to protect the soil from erosion.

This unit has potential for use as woodland. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 160. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 120. The potential highest average growth rate for Douglas fir is 170 cubic feet per acre per year at age 65. Trees of limited extent include western redcedar. Common forest understory plants include western swordfern, creambush oceanspray, red huckleberry, and trailing blackberry.

This map unit is in capability subclass IIw.

58-Getchell gravelly silt loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is on mountains. It formed in glacial till and volcanic ash underlain by dense glacial till. The native vegetation is mainly conifers. Elevation is 1,800 to 2,800 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 about 105 days.

Typically, the surface is covered with a mat of leaves and twigs 2 inches thick. The surface layer, where mixed to a depth of 6 inches, is brown gravelly silt loam. The subsoil is strong brown, dark brown, and dark yellowish brown gravelly silt loam 31 inches thick. Grayish brown, dense glacial till that crushes to gravelly loam is at a depth of about 37 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas phyllite is in the surface layer and subsoil and in the dense glacial till.

Included in this unit are small areas of Crinker soils, deep soils, and Rock outcrop on mountainsides.

Permeability of this Getchell soil is moderate to the substratum and very slow through it. Available water capacity is moderate to high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A perched water table fluctuates between depths of 18 and 36 inches from November to April.

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 for western hemlock is 129. On the basis of a 50-year site curve, the mean site index for western hemlock is 91. The highest average growth rate for western hemlock is 198 cubic feet per acre per year at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent are Pacific silver fir, Douglas fir, and western redcedar. Common forest understory plants are red huckleberry, deer fern, western brackenfern, ladyfern, bunchberry dogwood, and blueleaved huckleberry.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Occasional snowpack limits the use of equipment and restricts access. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by plant cover or adequate water bars are provided.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are present, natural reforestation of cutover areas by Pacific silver fir occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIe.

59-Giles silt loam. This very deep, well drained soil is on terraces. It formed in glacial outwash and volcanic ash. Slope is 0 to 3 percent. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 200 to 500 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface is covered with a mat of leaves, needles, and twigs 1 inch thick. The surface layer is very dark grayish brown silt loam 5 inches thick. The subsurface layer is dark grayish brown silt loam 13 inches thick. The subsoil is olive brown and dark yellowish brown silt loam 29 inches thick. The substratum to a depth of 60 inches or more is light olive brown silt loam. In some areas the substratum is stratified sand and silt. the subsoil is silty clay loam, the soil is 5 to 25 percent gravel, or the soil is moderately well drained,

Included in this unit are small areas of Kline soils on alluvial fans and Barneston soils on outwash terraces.

Permeability of this Giles 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 as hayland, pastureland, cropland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 173. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 130. The highest average growth rate for Douglas fir is 184 cubic feet per acre per year at age 60. Among the trees of limited extent are red alder, western redcedar, and western hemlock. Common forest understory plants are salal, red huckleberry. Oregongrape, western brackenfern, western swordfern, trailing blackberry, and salmonberry.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. 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 red alder occurs readily. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings.

This unit is well 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. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is suited to all crops commonly grown in the survey area. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, 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.

The main limitation of this unit for use as homesites is low soil strength. The main limitation for septic tank absorption fields is the moderate permeability. Use of additional topsoil placed over the absorption field and longer absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IIc.

60-Giles Variant silt loam. This very deep, well drained soil is on terraces. It formed in mixed alluvium. Slope is 0 to 3 percent. The native vegetation is mainly conifers. Elevation is 500 to 600 feet. The average annual precipitation is about 80 inches, the average

annual air temperature is about 51 degrees F, and the average frost-free season is 140 to 170 days.

Typically. the upper 6 inches of the surface layer is very dark grayish brown silt loam and the lower 9 inches is very dark grayish brown silty clay loam. The upper 12 inches of the subsoil is dark grayish brown silty clay loam, the next 6 inches is very dark grayish brown silt loam, and the lower 14 inches is dark brown loam. The substratum to a depth of 60 inches or more is dark grayish brown sandy loam.

Included in this unit are small areas of Barneston and Wickersham soils on outwash terraces and soils that are flooded by creek overflow.

Permeability of this Giles Variant soil is moderately 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.

This unit is used mainly as woodland. It is also used as hayland, pastureland, cropland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 163. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 125. The highest average growth rate for Douglas fir is 173 cubic feet per acre per year at age 65. Among the trees of limited extent are red alder, western hemlock, and western redcedar. Common forest understory plants are geranium, western swordfern, western brackenfern, vine maple, trailing blackberry, and northern twinflower.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are slippery and soft when wet. 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 red alder and western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings.

This unit is well suited to hay and pasture. Common forage plants are perennial grasses, legumes, oats. and corn, Animal manure can be properly applied on grass-legume crops periodically during the growing season. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff.

Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition.

This unit is well suited to use as cropland. Applying animal manure, returning all crop residue to the soil, and using cover crops help to maintain organic matter content, fertility, and tilth. Crusting of the surface and compaction of the soil can be reduced by returning crop residue to the soil and using minimum tillage.

The main limitation for homesite development is low soil strength. The main limitation for septic tank absorption fields is the moderately slow permeability. Use of additional topsoil placed over the absorption field and longer absorption lines helps to compensate for this limitation.

This map unit is in capability subclass IIc.

61-Gilligan silt loam. This very deep, well drained soil is on terraces. It formed in alluvium and glacial outwash. Slope is 0 to 3 percent. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 150 to 600 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark grayish brown silt loam 4 inches thick. The subsoil is yellowish brown and light olive brown silt loam 28 inches thick. The upper 15 inches of the substratum is olive sandy loam, and the lower part to a depth of 60 inches or more is olive extremely channery loamy sand. In some areas the surface layer is sandy loam or gravelly silt loam, in some areas the profile is stratified very channery and extremely channery sand at a depth of less than 40 inches, and in some areas the subsoil and substratum are silty clay loam.

Included in this unit are small areas of Cokedale and Larush soils on flood plains and Barneston soils on outwash terraces. Also included are small areas of soils that have properties associated with weathered volcanic ash.

Permeability of this Gilligan 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 as pastureland, hayland, cropland, woodland, and homesites.

This unit is well 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. In summer supplemental irrigation is

required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Fertilizer is needed to insure optimum growth of grasses and legumes.

This unit is suited to all crops commonly grown in the survey area. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, fertility, and tilth. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Crusting of the surface and compaction of the soil can be reduced by returning crop residue to the soil and by using minimum tillage.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 173. On the basis of a 50-year site curve, the mean site index for Douglas fir is 130. The highest average growth rate for Douglas fir is 184 cubic feet per acre per year at age 60. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. Common forest understory plants are western swordfern, blackberry, geranium, and vine maple.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. 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 red alder occurs readily. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings.

This unit is well suited to homesite development. It has few limitations.

This map unit is in capability subclass IIc.

62-Greenwater sandy loam. This very deep, somewhat excessively drained soil is on terraces. It formed in sandy alluvium derived mainly from andesite and pumice. Slope is 0 to 3 percent. The native vegetation is mainly conifers. Elevation is 350 to 600 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 170 days.

Typically, the surface is covered with a mat of needles, leaves. and twigs 2 inches thick. The surface layer, where mixed to a depth of 10 inches, is brown sandy loam. The subsoil is yellowish brown loamy sand. It has pumice fragments and is 22 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown sand. In some areas the surface layer is very gravelly sandy loam or loamy sand. In some areas the soil does not have pumice fragments, and in some areas a layer that is weakly cemented with iron is at a depth of 10 to 19 inches.

Included in this unit are small areas of Barneston soils on outwash terraces, Larush soils on alluvial terraces, Wickersham soils on alluvial fans, and Pilchuck soils on flood plains.

Permeability of this Greenwater soil is 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 as woodland. It is also used as hayland, pastureland, and homesites.

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 152 for Douglas fir and 164 for western hemlock. On the basis of a 50-year site curve, the mean site index is 117 for Douglas fir and 114 for western hemlock. The highest average growth rate for Douglas fir is 161 cubic feet per acre per year at age 60 and for western hemlock is 262 cubic feet per acre per year at age 50. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. Common forest understory plants are Oregongrape, western brackenfern, salal, western swordfern, trailing blackberry, 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. The surface layer is loose when dry, which limits the use of wheeled and tracked equipment.

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 western hemlock occurs periodically and by red alder it occurs readily. The moderate available water capacity of the soil during the growing season and droughtiness of the surface layer result in a high mortality rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This unit is limited for hay and pasture by droughtiness. In summer irrigation is needed for maximum production of most crops. Sprinkler irrigation

is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is well suited to homesite development. 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 IVs.

63-Guemes very stony loam, 30 to 70 percent slopes. This deep, well drained soil is on mountains. It formed in colluvium, residuum, and glacial till that are high in content of serpentine. The native vegetation is mainly conifers and shrubs. Elevation is 10 to 1,500 feet. The average annual precipitation is about 25 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is grayish brown very stony loam 8 inches thick. The upper 6 inches of the subsoil is brown extremely gravelly loam, the next 18 inches is dark brown extremely gravelly clay loam, and the lower 12 inches is dark yellowish brown extremely cobbly sandy clay loam. The substratum is olive brown very gravelly loam about 14 inches thick. Dense glacial till that crushes to very gravelly sandy loam is at a depth of about 58 inches. Depth to dense glacial till ranges from 40 to 60 inches. In some areas the substratum is extremely gravelly sand, and in some areas the surface layer is very gravelly loam.

Included in this unit are small areas of Rock outcrop and soils that are 20 to 40 inches deep to bedrock and are on mountainsides.

Permeability of this Guemes soil is moderately slow. Available water capacity is moderately high. Effective rooting depth is 40 to 60 inches. Runoff is rapid, and the hazard of water erosion is severe. A perched water table fluctuates between depths of 42 and 60 inches from November to March.

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 for Douglas fir is estimated to be 115. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 91. The highest average growth rate for Douglas fir is 106 cubic feet per acre per year at age 60. Among the trees of limited extent are western redcedar, lodgepole pine, and western hemlock. Common forest understory plants are salal, Oregongrape, western brackenfern, Pacific madrone, western swordfern, rhododendron, and rose.

The main limitation for the harvesting of timber is steepness of slope. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are slippery when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Establishing plant cover on steep cuts and fills 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 rifling and gullying unless they are protected by plant cover or adequate water bars are provided.

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 by lodgepole pine occurs periodically. The droughtiness of the surface layer increases the mortality rate of seedlings, especially on south- and southwest-facing side slopes. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. Trees on this unit exhibit poor growth and vigor because of the high content of magnesium in proportion to the content of calcium. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings.

This map unit is in capability subclass VIIs.

64-Guemes very gravelly loam, sandy substratum, 8 to 30 percent slopes. This deep, well drained soil is on mountainsides. It formed in colluvium derived from serpentine and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 10 to 1,500 feet. The average annual precipitation is about 25 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is reddish gray very gravelly loam 7 inches thick. The upper 13 inches of the subsoil is reddish brown and dark brown extremely gravelly clay loam, and the lower 10 inches is dark grayish brown extremely

gravelly sandy loam. The substratum to a depth of 60 inches or more is olive gray and dark gray very gravelly sand and extremely gravelly sand. In some small areas the substratum is extremely gravelly sandy loam or sandy clay loam.

Included in this unit are soils that have serpentine or dense glacial till at a depth of 20 to 40 inches and small areas of Rock outcrop on mountainsides.

Permeability of this Guemes soil is moderately slow in the subsoil and rapid in the substratum. Available water capacity is moderately high. 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 for Douglas fir is estimated to be 108. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 85. The highest average growth rate for Douglas fir is 95 cubic feet per acre per year at age 60. Among the trees of limited extent are western redcedar, lodgepole pine, and western hemlock. Common forest understory plants are salal, Oregongrape, western brackenfern, rhododendron, western swordfern, Pacific madrone, and rose.

This unit is well suited to year-round logging. Unsurfaced roads and skid trails are slippery when wet. 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 by lodgepole pine occurs periodically. The droughtiness of the surface layer increases the mortality rate of seedlings, especially on south- and southwest-facing side slopes. Trees on this unit exhibit poor growth and vigor because of the high content of magnesium in proportion to the content of calcium. When openings are made in the canopy. invading brushy plants can prevent the establishment of seedlings.

This map unit is in capability subclass IVe.

65-Guemes Variant-Rock outcrop complex, 30 to 70 percent slopes. This map unit is on coastal mountains and side slopes. Slopes are irregular and complex. The native vegetation is mainly conifers and .shrubs. Elevation is 10 to 1,500 feet. The average annual precipitation is about 25 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

This unit is about 70 percent Guemes Variant extremely gravelly loam and about 20 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 some soils that have a very gravelly sand substratum, soils that are more than 40 inches deep to serpentine, and soils that are moderately deep to dense glacial till and are on mountainsides.

The Guemes Variant soil is moderately deep and well drained. It formed in glacial till and residuum derived dominantly from serpentine. Typically, the surface layer is dark reddish brown extremely gravelly loam 6 inches thick. The subsoil is dark reddish brown extremely gravelly clay loam 18 inches thick. Serpentine is at a depth of 24 inches. Depth to serpentine ranges from 20 to 40 inches.

Permeability of the Guemes Variant soil is moderately slow. Available water capacity is very low to moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of hard and mostly unweathered serpentine. It occurs as steep cliffs and irregular formations.

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 for Douglas fir is estimated to be 90. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 70. The highest average growth rate for Douglas fir is 70 cubic feet per acre per year at age 70. Among the trees of limited extent are western redcedar and lodgepole pine. The areas of Rock outcrop make up about 20 percent of this unit and limit yields accordingly. Common forest understory plants are Oregongrape, western brackenfern, salal, red huckleberry, rose, and Pacific madrone.

The main limitation for the harvesting of timber is steepness of slope. 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. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Avoiding large areas of Rock outcrop forces yarding paths to converge, which results in compaction of the soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are

provided. Establishing plant cover on steep cuts and fills reduces erosion. Following road construction and clearcutting, road failures and landslides are likely to occur.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas fir seedlings. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. The restricted available water capacity of the soil during the growing season and droughtiness of the surface layer result in a high mortality rate of seedlings. If seed trees are present, natural reforestation of cutover areas by lodgepole pine occurs periodically. The areas of Rock outcrop limit the even distribution of reforestation. Trees on this unit exhibit poor growth and vigor because of the high content of magnesium in proportion to the content of calcium. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIIs.

66-Heisler gravelly silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on glaciated mountainsides. It formed in glacial till influenced by phyllite with an admixture of loess and volcanic ash. The native vegetation is mainly conifers. Elevation is 200 to 1,300 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free season is 140 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The upper 8 inches of the subsoil is dark reddish brown gravelly silt loam. and the lower 12 inches is dark brown very gravelly loam. The upper 8 inches of the substratum is light yellowish brown very gravelly sandy loam, and the lower part to a depth of 60 inches or more is light gray very gravelly loam. In some areas the subsoil is gravelly loam. and in some areas the substratum is less than 35 percent rock fragments.

Permeability of this Heisler soil is moderate. Available water capacity is moderately high to high. 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 species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 165. On the basis of a 50-year site curve, the mean site index for Douglas fir is 127. The highest average growth rate for Douglas fir is 176 cubic feet per acre per year at age 60. Among the trees of limited extent are red alder, western hemlock, western redcedar. and bigleaf maple. Common forest understory plants are western swordfern, Oregongrape, red huckleberry, deer fern, Pacific trillium, and bedstraw.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. 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 and slippery when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Following road construction and clearcutting, road failures and landslides are likely to occur.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas fir seedlings. The moderate available water capacity of the soil during the growing season and droughtiness of the surface layer result in a high mortality rate of 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 can prevent the establishment of seedlings.

This map unit is in capability subclass VIe.

67-Hoogdal silt loam, 8 to 15 percent slopes. This very deep, moderately well drained soil is on terraces. It formed in loess and glaciolacustrine sediment. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 100 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown silt loam 6 inches thick. The subsoil is olive brown and light yellowish brown silty clay loam 11 inches thick. The substratum to a depth of 60 inches or more is mottled, olive gray and olive silty clay. In some areas the surface layer is gravelly silt loam. In some areas the substratum has lenses of sandy material.

Included in this unit are small areas of Barneston and

Indianola soils on outwash terraces and Sehome and Tokul soils on hills.

Permeability of this Hoogdal soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 18 to 24 inches from December to March. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It is also used as hayland, pastureland, and homesites. The unit is suited to climatically adapted cultivated crops.

Douglas fir and western redcedar are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 156. On the basis of a 50-year site curve, the mean site index for Douglas fir is 124. The highest average growth rate for Douglas fir is 165 cubic feet per acre per year at age 60. Estimates of the site index and yield for western redcedar have not been made. Among the trees of limited extent are red alder and western hemlock. Common forest understory plants are red huckleberry. salal, Oregongrape, western swordfern, and salmonberry.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft and slippery when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Seasonal soil wetness limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Seedling establishment and the hazard of windthrow are the main concerns 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. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

The main limitation for hay and pasture is the perched water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Seedbed preparation should be on the contour or across the slope where practical.

This unit is limited for homesite development mainly by the perched water table, shrink-well potential, and steepness of slope. Tile drainage can be used to lower the water table if suitable outlets are available. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential. Septic tank absorption fields do not function properly because of wetness and slow permeability; effluent from the absorption fields may contaminate ground water. Community sewage systems are needed.

This map unit is in capability subclass IIIe.

68-Hoogdal silt loam, 15 to 30 percent slopes. This very deep, moderately well drained soil is on short upland slopes. It formed in loess and glaciolacustrine sediment. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 100 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark grayish brown silt loam 6 inches thick. The upper 5 inches of the subsoil is yellowish brown silty clay loam, and the lower 17 inches is light yellowish brown, olive, and olive gray silty clay. The substratum to a depth of 60 inches or more is olive gray clay. In some areas the surface layer is gravelly silt loam, and in some areas the substratum has lenses of sand.

Included in this unit are small areas of Barneston soils on outwash terraces and Tokul and Sehome soils on hills.

Permeability of this Hoogdal soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 18 to 24 inches from December to March. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It is also used as hayland. pastureland, and homesites.

Douglas fir and western redcedar are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 156. On the basis of a 50-year site curve, the mean site index for Douglas fir is 124. The highest average growth rate for Douglas fir is 165 cubic feet per acre per year at age 60. Estimates of the site index and yield for western redcedar have not been made. Among the

trees of limited extent are red alder and western hemlock. Common forest understory plants are red huckleberry. salal. Oregongrape, western swordfern, and salmonberry.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts. compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft and slippery when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Seasonal soil wetness limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Seedling establishment and the hazard of windthrow are the main concerns 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. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

The main limitation for hay and pasture is the perched water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Seedbed preparation should be on the contour or across the slope where practical.

This unit is limited for homesite development mainly by the perched water table, shrink-swell potential, and steepness of slope. Tile drainage can be used to lower the water table if suitable outlets are available. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential. Septic tank absorption fields do not function properly because of wetness, slow permeability, and steepness of slope. Effluent from septic tank absorption fields can surface in downslope areas and can contaminate ground water, creating a hazard to health. Community sewage systems are needed.

This map unit is in capability subclass IVe.

69-Hoogdal silt loam, 30 to 60 percent slopes. This very deep, moderately well drained soil is on terrace escarpments. It formed in loess and glaciolacustrine sediment. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 100 to 300 feet, The average annual precipitation is about 45 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown silt loam 6 inches thick. The subsoil is dark brown and brown silt loam 16 inches thick. The substratum to a depth of 60 inches or more is mottled, olive gray and light olive gray silty clay. In some areas the surface layer is gravelly silt loam, and in some areas the substratum has lenses of sand.

Included in this unit are small areas of Barneston soils on outwash terraces and Tokul soils on hills.

Permeability of this Hoogdal soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 18 to 24 inches from December to March. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Douglas fir and western redcedar are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 156. On the basis of a 50-year site curve, the mean site index for Douglas fir is 124. The highest average growth rate for Douglas fir is 165 cubic feet per acre per year at age 60. Estimates of the site index and yield for western redcedar have not been made. Among the trees of limited extent are red alder and western hemlock. Common forest understory plants are red huckleberry, salal, Oregongrape, western swordfern, and salmonberry.

The main limitation for the harvesting of timber is steepness of slope. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. 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 cuts and fills 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 they are protected by plant cover or adequate water bars are provided.

Seedling establishment and the hazard of windthrow are the main concerns 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. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIe.

70-Humskel gravelly sandy loam, 3 to 30 percent slopes. This moderately deep, well drained soil is on glacially modified mountains. It formed in volcanic ash and colluvium derived from metasedimentary rock. The native vegetation is mainly conifers. Elevation is 3,200 to 4,500 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 38 degrees F, and the average frost-free season is 70 to 100 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown gravelly sandy loam 2 inches thick. The upper 7 inches is dark reddish brown very gravelly sandy loam, and the lower 14 inches is strong brown and dark reddish brown very gravelly sandy loam. Argillite is at a depth of 23 inches. Depth to argillite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam, and in some areas the profile is moderately deep to dense glacial till or dunite.

Included in this unit are small areas of very deep soils that contain dunite fragments and very deep soils that contain mixed rock fragments and are on mountainsides. Also included are small areas of Rock outcrop and soils that have slopes of more than 30 percent.

Permeability of this Humskel soil is moderate. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. Runoff is slow. and the hazard of water erosion is slight.

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 for western hemlock is 105. On the basis of a 50-year site curve, the mean site index for western hemlock is 75. The highest average growth rate for western hemlock is 151 cubic feet per acre per year at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent are Pacific silver fir and mountain hemlock. Common forest understory plants are bunchberry dogwood, deer fern, tall blue huckleberry, and strawberryleaf raspberry.

The main limitation for the harvesting of timber is winter snowpack. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available only in some areas of this unit. Winter snowpack hinders the use of equipment and limits access in winter.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock, noble fir, and Pacific silver fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Low soil temperature in summer, deep snowpack, and a short growing season reduce the survival rate of planted and natural seedlings and delay their establishment. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIe.

71-Humskel gravelly sandy loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on glacially modified mountainsides. It formed in volcanic ash and colluvium derived from metasedimentary rock. The native vegetation is mainly conifers. Elevation is 3,200 to 4,500 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 38 degrees F, and the average frost-free season is 70 to 100 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown gravelly sandy loam 2 inches thick. The upper 7 inches of the subsoil is dark reddish brown very gravelly sandy loam, and the lower 14 inches is strong brown and dark reddish brown very gravelly sandy loam. Argillite is at a depth of 23 inches. Depth to argillite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly loam, and in some areas the profile is moderately deep to dense glacial till or dunite.

Included in this unit are some very deep soils that contain dunite fragments and some very deep soils that contain rock fragments of mixed mineralogy and are on mountainsides, Also included are small areas of Rock outcrop.

Permeability of this Humskel soil is moderate.

Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. 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 for western hemlock is 105. On the basis of a 50-year site curve, the mean site index for western hemlock is 75. The highest average growth rate for western hemlock is 151 cubic feet per acre per year at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent are Pacific silver fir and mountain hemlock. Common forest understory plants are bunchberry dogwood, deer fern, tall blue huckleberry, and strawberryleaf raspberry.

The main limitations for the harvesting of timber are steepness of slope and winter snowpack. Logging roads require suitable surfacing for year-round use. Rock for road construction is in some included areas, but generally it is not readily available on this unit. Winter snowpack hinders the use of equipment and limits access in winter.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock, noble fir, and Pacific silver fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Low soil temperature in summer, deep snowpack, and a short growing season reduce the survival rate of planted and natural seedlings and delay their establishment. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIe.

72-Hydraquents, tidal. These very deep, poorly drained soils are on tidelands. They formed in alluvium. Slope is 0 to 1 percent. The native vegetation is mainly salt-tolerant grasses and shrubs. Elevation is 0 to 2 feet. The average annual precipitation is about 25 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of dead grass about 1 inch thick. The surface layer is dark gray fine sandy loam 6 inches thick. The underlying material to a depth of 60 inches or more is gray and olive gray, stratified silt loam, very fine sandy loam, and fine sandy loam. In some areas the profile is silty clay loam.

Included in this unit are areas of soils that are devoid of vegetation.

Permeability of these Hydraquents is moderate. Available water capacity is high. A high water table is at the surface to 12 inches above the surface during periods of high tide. Runoff is very slow, and the hazard of water erosion is slight. These soils are subject to frequent, brief periods of flooding during daily high tides.

This unit is used as wildlife habitat and recreation.

This map unit is in capability subclass VIIw.

73-Illabot very gravelly loam, 3 to 30 percent slopes. This moderately deep, moderately well drained soil is on glacially modified mountainsides. It formed in volcanic ash and glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 1,000 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 120 to 150 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown very gravelly loam 3 inches thick. The upper 6 inches of the subsoil is yellowish brown very gravelly loam, and the lower 21 inches is light olive brown very gravelly loam. Olive brown, dense glacial till that crushes to very gravelly sandy loam is at a depth of about 30 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the surface layer is gravelly loam, and in some areas bedrock is at a depth of 20 to 40 inches.

Included in this unit are areas of Elwell, Kindy, Oakes, and Sorensen soils on mountainsides. Also included are small areas of Rock outcrop.

Permeability of this Illabot soil is moderate above the dense glacial till and very slow through the till. Available water capacity is very low to low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the dense glacial till at a depth of 24 to 36 inches from November to May.

Most areas of this unit are used as woodland. A few areas are used as homesites.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for western hemlock is 139. On the basis of a 50-year site curve, the mean site index for western hemlock is 98. The highest average growth rate

for western hemlock is 216 cubic feet per acre per year at age 60. Among the trees of limited extent is Douglas fir. Common forest understory plants are salal, Oregongrape. western swordfern, western brackenfern, northern twinflower, red huckleberry, and vine maple.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Cutbanks may slump when the soil is saturated.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are present. natural reforestation of cutover areas by western hemlock occurs readily. The droughtiness of the surface layer reduces the survival rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This unit is limited for homesite development mainly by the perched water table, very slow permeability of the dense glacial till, and steepness of slope in some areas. Tile drainage can be used to lower the water table if suitable outlets are available. Septic tank absorption fields do not function properly because of wetness. very slow permeability, and steepness of slope in some areas. In the steeper areas, effluent from septic tank absorption fields can surface in downslope areas and thus create a hazard to health. Also, effluent from the absorption fields may contaminate ground water. Community sewage systems are needed.

This map unit is in capability subclass IVe.

74-Illabot very gravelly loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is on glacially modified mountainsides. It formed in volcanic ash and glacial till. The native vegetation is mainly conifers and hardwoods. Elevation is 1,000 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 120 to 150 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown very gravelly loam 3 inches thick. The upper 6 inches of the subsoil is yellowish brown very gravelly loam, and the lower 21 inches is light olive brown very gravelly loam. Olive brown, dense glacial till that crushes to very gravelly sandy loam is at a depth of about 30 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the surface layer is gravelly loam, and in some areas bedrock is at a depth of 20 to 40 inches.

Included in this unit are small areas of Elwell, Kindy, Oakes, and Sorensen soils on mountainsides. Also included are small areas of Rock outcrop.

Permeability of this Illabot soil is moderate above the dense glacial till and very slow through the till. Available water capacity is very low to low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 24 to 36 inches from November to May.

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 for western hemlock is 139. On the basis of a 50-year site curve, the mean site index for western hemlock is 98. The highest average growth rate for western hemlock is 216 cubic feet per acre per year at age 60. Among the trees of limited extent is Douglas fir. Common forest understory plants are salal, Oregongrape, western swordfern, western brackenfern, northern twinflower, red huckleberry, and vine maple.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs readily. The droughtiness of the surface layer reduces the survival rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass Vle.

75-Indianola sandy loam, 0 to 5 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in sandy glacial drift. The native vegetation is mainly conifers. Elevation is 50 to 600 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 50 degrees F. and the average frost-free season is 160 to 210 days.

Typically. the surface is covered with a mat of needles. leaves, and twigs 2 inches thick. The surface layer is very dark brown sandy loam 6 inches thick. The upper 5 inches of the subsoil is dark brown loamy fine sand. and the lower 18 inches is dark brown and dark yellowish brown loamy sand. The substratum to a depth of 60 inches or more is yellowish brown sand. In some areas the surface layer is gravelly sandy loam.

Included in this unit are some areas of soils that have a sandy loam subsoil, soils that have a stratified silt and clay substratum, and soils that are underlain by dense glacial till. Also included are small areas of Kline and Wickersham soils on alluvial fans, Barneston and Skipopa soils on terraces, and Sehome and Tokul soils on hills.

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

Most areas of this unit are used as woodland. A few areas are used as hayland, pastureland, cropland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 151. On the basis of a 50-year site curve, the mean site index for Douglas fir is 115. The highest average growth rate for Douglas fir is 159 cubic feet per acre per year at age 60. Among the trees of limited extent are red alder, western hemlock. bigleaf maple, and western redcedar. Common forest understory plants are western brackenfern, salal, western swordfern. Oregongrape, and evergreen huckleberry.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Unsurfaced roads and skid trails are soft. 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 periodically. The droughtiness of the surface layer increases the mortality rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

The main limitations for pasture, hay,, and cultivated crops are droughtiness and low soil fertility. Rotation grazing helps to maintain the quality of forage. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is well suited to homesite development. The main limitation for septic tank absorption fields is the poor filtering capacity of the soil. 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 IVs.

76-Jackman gravelly loam, 30 to 65 percent slopes. This very deep, well drained soil is on glacially modified mountains. It formed in colluvium containing volcanic ash and glacial till influenced by dunite. The native vegetation is mainly conifers. Elevation is 2,500 to 4,200 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 90 to 110 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The upper 4 inches of the subsoil is strong brown gravelly loam, and the lower 11 inches is dark yellowish brown very gravelly loam. The upper 12 inches of the substratum is olive brown very gravelly loam, and the lower part to a depth of 60 inches or more is olive very gravelly sandy loam. In some areas the upper part of the subsoil is very gravelly sandy loam.

Included in this unit are some soils that are moderately deep to dunite. dense glacial till, or argillite.

Permeability of this Jackman soil is moderate. Available water capacity is moderately high to high. 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 for western hemlock is estimated to be 70. On the basis of a 50-year site curve, the mean site index for western hemlock is estimated to be 55. The

highest average growth rate for western hemlock is 73 cubic feet per acre per year at age 60. Among the trees of limited extent are Pacific silver fir and Alaska cedar. Common forest understory plants are tall blue huckleberry, deer fern, strawberryleaf raspberry, and plantain.

The main limitations for the harvesting of timber are steepness of slope and winter snowpack. 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. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Winter snowpack limits the use of equipment and restricts access. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting western hemlock seedlings. Trees on this unit exhibit poor growth and vigor. Droughtiness of the surface layer reduces the survival rate of seedlings, especially on south- and southwest-facing side slopes. If seed trees are present, natural reforestation of cutover areas by western hemlock, Pacific silver fir, and Alaska cedar occurs periodically.

This map unit is in capability subclass VIe.

77-Jug very gravelly loam, 0 to 30 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers. Elevation is 1,000 to 1,800 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 100 to 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer, where mixed to a depth of 7 inches, is dark brown very gravelly loam. The subsoil is strong brown extremely cobbly sandy loam about 9 inches thick. The upper 24 inches of the substratum is dark yellowish brown extremely cobbly loamy sand, and the lower part to a depth of 60 inches or more is dark yellowish brown extremely cobbly sand. Depth to sand and gravel ranges from 14 to 20 inches. In some areas the surface layer is sandy loam or loam.

Included in this unit are small areas of Elwell and Sorensen soils on low mountains and Birdsview and Saxon soils on terraces.

Permeability of this Jug soil is moderately rapid in the subsoil and very rapid in the substratum. Available water capacity is moderate to moderately high. 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.

Western hemlock and Douglas fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 156 for western hemlock and 169 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 111 for western hemlock and 129 for Douglas fir. The highest average growth rate is 248 cubic feet per acre per year for western hemlock at age 50 and 180 cubic feet per acre per year for Douglas fir at age 60. Among the trees of limited extent are Pacific silver fir, western redcedar, and red alder. Common forest understory plants are red huckleberry, Oregongrape, salal, princes pine, and western swordfern.

The main limitations for the harvesting of timber are poor traction and soil compaction during the rainy season. Material cast to the side ravels and commonly sloughs when saturated. Use of wheeled and tracked equipment when the soil is wet produces ruts, compacts the soil, and damages roots of trees. Logging roads require suitable surfacing for year-round use. Rounded rock for road construction is readily available on this unit. Gravel for road surfacing is also available. Occasional snowpack limits the use of equipment and restricts access.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting western hemlock and Douglas fir seedlings. The droughtiness of the surface layer increases the mortality rate of seedlings, especially on south- and southwest-facing side slopes. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass IVe.

78-Keystone loamy sand, 0 to 8 percent slopes. This very deep, excessively drained soil is on kames, moraines, and outwash plains. It formed in sandy glacial drift. The native vegetation is mainly conifers. Elevation is near sea level to 300 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer, where mixed to a depth of 7 inches, is dark brown loamy sand. The subsoil is dark yellowish brown loamy sand 8 inches thick. The substratum to a depth

of 60 inches or more is light olive brown, grayish brown, and olive brown sand. In some areas the surface layer is sandy loam to a depth of 10 inches, in some areas the profile is 15 to 35 percent rock fragments, and in some areas dense glacial till is at a depth of 40 to 60 inches.

Included in this unit are small areas of soils that have a sandy loam subsoil and soils that have properties associated with weathered volcanic ash. Also included are small areas of Bow soils on glaciated remnant terraces and Clallam soils on glaciated uplands.

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

Most areas of this unit are used as woodland. A few areas are used as pastureland, hayland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 141. On the basis of a 50-year site curve, the mean site index for Douglas fir is 109. The highest average growth rate for Douglas fir is 146 cubic feet per acre per year at age 65. Among the trees of limited extent are grand fir and western redcedar. Common forest understory plants are Indian plum, stinging nettle, Oregongrape, western swordfern, rose, and bedstraw.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Unsurfaced roads and skid trails are soft. 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 grand fir occurs periodically. The droughtiness of the surface layer increases the mortality rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

The main limitations for pasture and hay are droughtiness and low soil fertility. Rotation grazing helps to maintain the quality of forage. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is well suited to homesite development. The main limitation for septic tank absorption fields is the poor filtering capacity of the soil. 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 IVs.

79-Keystone loamy sand, 8 to 30 percent slopes. This very deep, excessively drained soil is on kames and moraines. It formed in sandy glacial drift. The native vegetation is mainly conifers. Elevation is 10 to 300 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer, where mixed to a depth of 7 inches, is dark brown loamy sand. The subsoil is dark yellowish brown loamy sand 8 inches thick. The substratum to a depth of 60 inches or more is light olive brown, grayish brown, and olive brown sand. In some areas the surface layer is sandy loam to a depth of 10 inches, in some areas the profile is 15 to 35 percent rock fragments, and in some areas dense glacial till is at a depth of 40 to 60 inches.

Included in this unit are small areas of soils that have a sandy loam subsoil and soils that have properties associated with weathered volcanic ash. Also included are small areas of Bow soils on glaciated remnant terraces and Clallam soils on glaciated uplands.

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

Most areas of this unit are used as woodland. A few areas are used as homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 141. On the basis of a 50-year site curve, the mean site index for Douglas fir is 109. The highest average growth rate for Douglas fir is 146 cubic feet per acre per year at age 65. Among the trees of limited extent are grand fir and western redcedar. Common forest understory plants are Indian plum, stinging nettle, Oregongrape, western swordfern, rose, and bedstraw.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Unsurfaced roads and skid trails are soft. 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 grand fir occurs periodically. The droughtiness of the surface layer increases the mortality rate of seedlings,

especially on south- and southwest-facing side slopes. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

If this unit is used for homesite development, the main limitation is steepness of slope. Cutbanks are not stable and are subject to slumping. In the less sloping areas. absorption lines should be installed on the contour. In the steeper areas, effluent from septic tank absorption fields can surface in downslope areas and thus create a hazard to health. 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 IVe.

80-Kindy gravelly silt loam, 3 to 30 percent slopes. This moderately deep, moderately well drained soil is on glacially modified mountains. It formed in volcanic ash, loess, colluvium, and glacial till. The native vegetation is mainly conifers. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 80 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 needles, leaves, and twigs 5 inches thick. The surface layer is pinkish gray gravelly silt loam 4 inches thick. The subsoil is dark brown and strong brown very gravelly silt loam 15 inches thick. The substratum is light olive brown very gravelly loam about 7 inches thick. Olive brown, dense glacial till that crushes to very gravelly loam is at a depth of about 26 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the profile is less than 35 percent rock fragments.

Included in this unit are some deep soils, soils that are derived from phyllite, and soils that are moderately deep to bedrock. Also included are small areas of Rock outcrop.

Permeability of this Kindy soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to high. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the dense glacial till at a depth of 18 to 36 inches from November to April.

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 for western hemlock is 135. On the basis of a 50-year site curve, the mean site index for western hemlock is 96. The highest annual growth rate for western hemlock is 209 cubic feet per acre per year at age 50. Among the trees of limited extent are Pacific silver fir and western redcedar. Common forest understory plants are tall blue huckleberry, salmonberry, oneleaf foamflower, deer fern, and western brackenfern.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil. and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Establishing plant cover on steep cuts and fills reduces erosion. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by Pacific silver fir occurs periodically. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by the dense till layer, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIe.

81-Kindy gravelly silt loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is on glacially modified mountains. It formed in volcanic ash, loess, colluvium, and glacial till. The native vegetation is mainly conifers. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 80 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 needles, leaves, and twigs 2.5 inches thick. The surface layer is pinkish gray gravelly silt loam 4 inches thick. The upper 3 inches of the subsoil is reddish brown gravelly silt loam, the next 3 inches is strong brown gravelly loam, and the lower 14 inches is dark yellowish brown very gravelly loam. The substratum is dark grayish brown very gravelly loam about 10 inches thick. Olive brown, dense glacial till that crushes to very gravelly loam is at a depth of about 34 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the profile is less than 35 percent rock fragments.

Included in this unit are some deep soils, soils that have phyllite fragments in the subsoil and substratum, and soils that are moderately deep to bedrock. Also included are small areas of Rock outcrop.

Permeability of this Kindy soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 18 to 36 inches from November to April.

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 for western hemlock is 135. On the basis of a 50-year site curve, the mean site index for western hemlock is 96. The highest average growth rate for western hemlock is 209 cubic feet per acre per year at age 50. Among the trees of limited extent are Pacific silver fir and western redcedar. Common forest understory plants are tall blue huckleberry, salmonberry, oneleaf foamflower, deer fern, and western brackenfern.

The main limitation for the harvesting of timber is steepness of slope. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths. skid trails, and firebreaks are subject to rifling and gullying unless they are protected by plant cover or adequate water bars are provided. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff. Occasional snowpack limits the use of equipment and restricts access.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by Pacific silver fir occurs periodically. The mortality rate of seedlings is higher on ridgetops that are subject to strong. persistent winds than it is in other areas of this unit. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by the dense glacial till layer, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIe.

82-Klawatti gravelly loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on mountainsides and ridgetops. It formed in colluvium derived from dunite and volcanic ash, The native vegetation is mainly conifers. Elevation is 3,200 to 4,200 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 40 degrees F, and the average frost-free season is 85 to 105 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 7 inches thick. The upper 6 inches of the subsoil is yellowish red gravelly loam, the next 13 inches is strong brown very cobbly loam, and the lower 9 inches is strong brown very gravelly loam. Dunite is at a depth of 28 inches. Depth to dunite ranges from 20 to 40 inches. In some areas the soil is dominantly volcanic ash, and in some areas it is moderately deep to dense glacial till.

Included in this unit are some deep soils, soils that contain phyllite fragments, and soils that are less than 35 percent rock fragments. Also included are small areas of Rock outcrop.

Permeability of this Klawatti soil is moderate. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. 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 for western hemlock is estimated to be 70. On the basis of a 50-year site curve, the mean site index for western hemlock is estimated to be 55. The highest average growth rate for western hemlock is 73 cubic feet per acre per year at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent are Pacific silver fir, Alaska cedar, and mountain hemlock. Common forest understory plants are blueleaved huckleberry, red huckleberry, and princes pine.

The main limitations for the harvesting of timber are steepness of slope and winter snowpack. 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. Logging roads require suitable surfacing for year-round

use. Rock for road construction is readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided. Winter snowpack limits the use of equipment and restricts access.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock seedlings. If seed trees are present, natural reforestation of cutover areas by Pacific silver fir and Alaska cedar occurs periodically. Seedlings and trees on this unit exhibit poor survival, growth, and vigor. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. Because the rooting depth is restricted by the underlying bedrock, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIe.

83-Kiawatti-Rock outcrop complex, 30 to 65 percent slopes. This map unit is on mountains. The native vegetation is mainly conifers. Elevation is 3,500 to 4,200 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 40 degrees F, and the average frost-free season is 85 to 105 days.

This unit is about 70 percent Klawatti gravelly loam and about 25 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 some soils that are more than 40 inches deep to dunite.

The Klawatti soil is moderately deep and well drained. It formed in colluvium derived dominantly from dunite and volcanic ash. Typically, the surface is covered with a mat of forest litter 4 inches thick. The upper 9 inches of the subsoil is dark reddish brown and dark brown gravelly loam, and the lower 15 inches is strong brown very gravelly loam. Dunite is at a depth of 24 inches. Depth to bedrock ranges from 20 to 40 inches.

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

Rock outcrop consists of exposures of hard and mostly unweathered dunite. It occurs as steep cliffs and irregular formations.

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 for western hemlock is estimated to be 70. On the basis of a 50-year site curve, the mean site index for western hemlock is estimated to be 55. The highest average growth rate for western hemlock is 73 cubic feet per acre per year at age 60. The areas of Rock outcrop make up about 25 percent of this unit and limit yields accordingly. Areas on ridgetops that are subject to strong, persistent winds are less productive than are other areas of this unit. Among the trees of limited extent are Pacific silver fir, Alaska cedar, and mountain hemlock. Common forest understory plants are blueleaved huckleberry, red huckleberry, and princes pine.

The main limitations for the harvesting of timber are steepness of slope and the 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 soil less. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Avoiding large areas of Rock outcrop forces yarding paths to converge, which results in compaction of the soil. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided. Winter snowpack limits the use of equipment and restricts access.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock seedlings. If seed trees are present, natural reforestation of cutover areas by Pacific silver fir and Alaska cedar occurs periodically. Seedlings and trees on this unit exhibit poor survival, growth, and vigor. The areas of Rock outcrop limit even distribution of reforestation. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. Because the rooting depth is restricted by the underlying bedrock, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIIe.

84-Kline very gravelly sandy loam, 0 to 8 percent slopes. This very deep, somewhat excessively drained

soil is on alluvial fans. It formed in mixed alluvium. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 100 to 1,000 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 140 to 170 days.

Typically, the surface is covered with a mat of needles. leaves, and twigs 1 inch thick. The surface layer is black very gravelly sandy loam 3 inches thick. The upper 12 inches of the underlying material is very dark gray extremely gravelly loamy sand, and the lower part to a depth of 60 inches or more is very dark gray and dark gray extremely gravelly sand. Depth to extremely gravelly sand ranges from 3 to 15 inches. In some areas the surface layer is loam, silt loam, or gravelly loam, the surface layer and underlying material have an admixture of volcanic ash, the profile has phyllite rock fragments. or the profile is very cobbly throughout.

Included in this unit are small areas of Sehome and Tokul soils on glaciated uplands and Barneston and Winston soils on terraces.

Permeability of this Kline soil is moderately rapid. Available water capacity is low. Effective rooting depth is limited by a seasonal high water table that is at a depth of 48 to 60 inches from January to March. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, very brief periods of flooding from December to March.

This unit is used mainly as woodland. It is also used as hayland, pastureland, cropland. and homesites.

Douglas fir is the main woodland species on the Kline soil. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 134. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 106. The highest average growth rate for Douglas fir is 136 cubic feet per acre per year at age 70. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Common forest understory plants are western swordfern. western brackenfern, salal. currant, and red huckleberry.

This unit is well suited to year-round logging. Logging roads require suitable surfacing for year-round use. Rounded rock for road construction is 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 periodically. The low available water capacity of the soil during the growing season and droughtiness of the surface layer result in a high mortality rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This unit is limited for hay. pasture, and cropland by droughtiness. In summer irrigation is needed for maximum production of most crops. Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plants nutrients.

The main limitation for homesites is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from 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.

This map unit is in capability subclass VIs.

85-Laconner very gravelly loamy sand, 0 to 8 percent slopes. This moderately deep, moderately well drained soil is on hills and terraces. It formed in glacial drift and an admixture of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 400 feet. The average annual precipitation is about 22 inches. the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs less than 1 inch thick. The surface layer, where mixed to a depth of 6 inches, is dark brown very gravelly loamy sand. The subsoil is dark brown and dark yellowish brown very gravelly loamy sand 13 inches thick. The upper 13 inches of the substratum is dark grayish brown very gravelly sand, and the lower 6 inches is light olive brown very gravelly loamy sand. The next 17 inches is grayish brown, dense glacial till that crushes to very gravelly fine sandy loam. Below this to a depth of 60 inches or more is light olive brown very gravelly loamy sand. Depth to dense glacial till ranges from 25 to 40 inches. In some areas the surface layer is gravelly loam or gravelly sandy loam, and in some areas the profile is more than 40 inches deep to dense glacial till.

Included in this unit are small areas of Coveland soils in upland swales, Bow soils on glaciated remnant terraces, and Swinomish soils on ridges of hills.

Permeability of this Laconner soil is rapid above the dense glacial till and very slow through the till. Available water capacity is very low to low. Effective rooting depth

Figure 2-Douglas fir in an area of Laconner very gravelly loamy sand, 0 to 8 percent slopes, on Guemes Island.

is 25 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A perched water table fluctuates between depths of 24 and 36 inches from November to April.

This unit is used mainly as woodland. A few areas are used as hayland, pastureland, and homesites.

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 for Douglas fir is estimated to be 125. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 95. The highest average growth rate for Douglas fir is 122 cubic feet per acre per year at age 70. Among the trees of limited extent are grand fir and western redcedar. Common forest understory plants are Oregongrape, western swordfern, red huckleberry, stinging nettle, Indian plum, and salal.

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 and the hazard of windthrow are the main concerns 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 grand fir occurs periodically. The droughtiness of the surface layer increases the mortality rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods

when the soil is excessively wet and the winds are strong.

This unit is limited for hay and pasture by droughtiness. In summer irrigation is needed for maximum production of most crops. Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

The main limitations for homesite development and septic tank absorption fields are depth to dense glacial till and the perched water table. Wetness can be reduced by installing drain tile around footings. The dense glacial till is rippable and therefore is not a serious limitation for most engineering uses. Use of interceptor drains, additional topsoil placed over the absorption field, and longer absorption lines placed on the contour helps to compensate for the limitations of the soil in this unit for septic tank absorption fields. 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 VIs.

86-Laconner very gravelly loamy sand, 8 to 15 percent slopes. This moderately deep, moderately well drained soil is on hills and terraces. It formed in glacial drift and an admixture of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 400 feet. The average annual precipitation is about 22 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface is covered with a mat of needles,, leaves, and twigs less than 1 inch thick. The surface layer, where mixed to a depth of 6 inches, is very dark brown very gravelly loamy sand. The subsoil is dark brown and dark yellowish brown very gravelly loamy sand 13 inches thick. The upper 13 inches of the substratum is dark grayish brown very gravelly loamy sand, and the lower 6 inches is light olive brown very gravelly loamy sand. The next 17 inches is grayish brown, dense glacial till that crushes to very gravelly fine sandy loam. Below this to a depth of 60 inches or more is light olive brown very gravelly loamy sand. Depth to dense glacial till ranges from 25 to 40 inches. In some areas the surface layer is gravelly loam, in some areas the subsoil is very gravelly sandy loam, and in some areas dense glacial till is at a depth of more than 40 inches.

Included in this unit are small areas of Coveland soils in swales on hills, Bow soils on glaciated remnant terraces, and Laconner soils that have slopes of more than 15 percent.

Permeability of the Laconner soil is rapid above the dense glacial till and very slow through the till. Available water capacity is very low to low. Effective rooting depth is 25 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A perched water table fluctuates between depths of 24 and 36 inches from November to April.

This unit is used mainly as woodland. A few areas are used as hayland, pastureland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 125. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 95. The highest average growth rate for Douglas fir is 122 cubic feet per acre per year at age 70. Among the trees of limited extent are grand fir and western redcedar. Common forest understory plants are Oregongrape, western swordfern, red huckleberry, stinging nettle, Indian plum, and salal.

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 and the hazard of windthrow are the main concerns 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 grand fir occurs periodically. The droughtiness of the surface layer increases the mortality rate of seedlings, especially on south- and southwest-facing side slopes. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This unit is limited for hay and pasture by droughtiness. In summer irrigation is needed for maximum production of most crops. Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

The main limitations for homesite development and septic tank absorption fields are depth to dense glacial till, the perched water table, and steepness of slope. Wetness can be reduced by installing drain tile around footings. The dense glacial till is rippable and therefore is not a serious limitation for most engineering uses.

Steepness of slope makes the construction of homes and streets more difficult. Use of interceptor drains, additional topsoil placed over the absorption field, and longer absorption lines placed on the contour helps to compensate for the limitations of the soil in this unit for septic tank absorption fields. 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 VIs.

87-Larush fine sandy loam. This very deep, well drained soil is on flood plains and terraces along major streams. It formed in alluvium. Slope is 0 to 5 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 100 to 500 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 52 degrees F. and the average frost-free season is 180 to 220 days.

Typically. the surface is covered with a mat of needles. leaves. and twigs 1 inch thick. The surface layer, where mixed to a depth of 10 inches, is dark grayish brown fine sandy loam. The subsoil is olive brown. dark grayish brown, and light olive brown very fine sandy loam and silt loam 19 inches thick. The substratum to a depth of 60 inches or more is olive gray fine sand. In some areas the upper part of the profile is gravelly sandy loam.

Included in this unit are small areas of Barneston, Gilligan, and Greenwater soils on terraces and small areas of Riverwash.

Permeability of this Larush soil is moderate. Available water capacity is moderately high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, brief periods of flooding from November to April.

This unit is used mainly as cropland, hayland, and pastureland. It is also used as woodland and homesites.

The main limitation of this unit for use as cropland is the hazard of flooding. Adequate construction and proper maintenance of dikes reduce the hazard of flooding. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, fertility, and tilth. This unit is well suited to specialty crops that require good drainage.

Common forage plants on this unit are perennial grasses, legumes, oats. and corn. Use of proper stocking rates. pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Applying animal manure and returning crop residue to the soil help to maintain organic matter content, fertility, and tilth. Animal manure can be properly applied on grass-legume crops periodically during the growing season.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 162. On the basis of a 50-year site curve, the mean site index for Douglas fir is 131. The highest average growth rate for Douglas fir is 172 cubic feet per acre per year at age 65. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. Common forest understory plants are geranium, western swordfern, western brackenfern, vine maple, trailing blackberry, and northern twinflower.

Occasional, brief periods of flooding reduce root respiration, which results in a low survival rate of seedlings. This unit is well suited to year-round logging. Unsurfaced roads and skid trails are soft. 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 red alder occurs readily. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings.

If this unit is used for homesite development, the main limitation is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be located above the expected flood level.

This map unit is in capability subclass IIw.

88-Larush silt loam. This very deep, well drained soil is on flood plains and terraces along major streams. It formed in alluvium. Slope is 0 to 3 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 100 to 500 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is very dark grayish brown silt loam 15 inches thick. The subsoil is dark grayish brown silt loam 9 inches thick. The upper 17 inches of the substratum is dark grayish brown fine sand, and the lower part to a depth of 60 inches or more is dark grayish brown silt loam with thin strata of fine sand. Depth to sandy material ranges from 15 to 30 inches. In some areas

the surface layer is fine sandy loam, the substratum is fine sandy loam, the subsoil is dominated by volcanic ash, or the surface layer is light-colored.

Included in this unit are small areas of Kline soils on alluvial fans. Birdsview soils on terraces, and soils that have slopes of more than 3 percent and are on terrace escarpments.

Permeability of this Larush 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 soil is subject to occasional, brief periods of flooding from November to April.

This unit is used mainly as cropland, hayland, and pastureland. It is also used as woodland and homesites.

The main limitation of this unit for use as cropland is the hazard of flooding. Adequate construction and proper maintenance of dikes reduce the hazard of flooding. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, fertility, and tilth. Crusting of the surface and compaction of the soil can be reduced by returning crop residue to the soil and using minimum tillage.

Common forage plants on this unit are perennial grasses. legumes, oats, and corn. Use of proper stocking rates. pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Applying animal manure and returning crop residue to the soil help to maintain organic matter content, fertility, and tilth. Animal manure can be properly applied on grass-legume crops periodically during the growing season.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 162. On the basis of a 50-year site curve, the mean site index for Douglas fir is 131. The highest average growth rate for Douglas fir is 172 cubic feet per acre per year at age 65. Among the trees of limited extent are red alder, western hemlock, western redcedar. and bigleaf maple. Common forest understory plants are geranium. western swordfern. western brackenfern, vine maple, trailing blackberry, and northern twinflower.

The main limitations for the harvesting of timber are muddiness caused by seasonal soil wetness and occasional. brief periods of flooding. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. 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 red alder occurs readily. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings.

If this unit is used for homesite development, the main limitation is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be located above the expected flood level.

This map unit is in capability subclass IIw.

89-Larush Variant silt loam. This very deep, moderately well drained soil is on alluvial fans and old stream terraces. It formed in alluvium with an admixture of volcanic ash. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 25 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 160 to 200 days.

Typically, the surface layer is dark brown silt loam 9 inches thick. The upper 5 inches of the subsoil is dark yellowish brown loam, and the lower 5 inches is light olive brown sandy loam. The substratum to a depth of 60 inches or more is brown, pale olive, yellowish brown, and light olive brown, stratified sandy loam to silty clay loam. In some areas the surface layer is gravelly loam.

Included in this unit are some soils that are poorly drained and are clayey or silty and gray soils that are high in content of talc.

Permeability of this Larush Variant soil is moderately 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 36 inches from November to May. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare periods of flooding.

This unit is used as cropland, hayland, and pastureland.

This unit is suited to all crops commonly grown in the survey area. Artificial drainage permits field operations to be conducted earlier and increases yields of perennial crops. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, fertility, and tilth. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

Common forage plants on this unit are perennial grasses, legumes, oats, and corn. Applying animal manure and returning crop residue to the soil help to

maintain organic matter content, fertility, and tilth. Animal manure can be properly applied on grass-legume crops periodically during the growing season.

This unit has potential for use as woodland. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 165. On the basis of a 50-year site curve. the mean site index for Douglas fir is estimated to be 130. The potential highest average growth rate for Douglas fir is 176 cubic feet per acre per year at age 60. The trees of limited extent include western hemlock, western redcedar, and red alder. Common forest understory plants include stinging nettle, Oregongrape.. western swordfern, northern twinflower. false Solomons seal, and ladyfern.

This map unit is in capability subclass IIw.

90-Lithic Haploxerolls-Rock outcrop complex, 70 to 90 percent slopes. This map unit is on the face of cliffs and mountainsides that support sparse vegetation. Areas are irregular in shape and are 40 to 100 acres in size. The native vegetation is mainly grasses, shrubs, and clumps of conifers. Elevation is 50 to 1,500 feet. The average annual precipitation is 20 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is 180 to 210 days.

This unit is about 60 percent Lithic Haploxerolls and about 25 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 soils that are more than 10 inches thick.

The Lithic Haploxerolls are shallow and well drained. They formed in loess and residuum derived dominantly from argillite. No single profile is representative of these soils. but one commonly observed in the survey area has a profile of black very gravelly loam about 8 inches thick over argillite. Depth to argillite ranges from 4 to 10 inches. In some areas the soils are moderately deep to argillite.

Permeability of the Lithic Haploxerolls is moderate. Available water capacity is very low. Effective rooting depth is 4 to 10 inches. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of hard and mostly unweathered argillite. It occurs as steep cliffs and irregular formations.

This unit is used as wildlife habitat and recreation. This map unit is in capability subclass VIIs.

91-Marblemount-Rock outcrop complex, 65 to 90 percent slopes. This map unit is on glaciated mountainsides. The native vegetation is mainly conifers. Elevation is 800 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 110 to 150 days.

This unit is about 60 percent Marblemount very stony sandy loam and about 25 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 deep soils and soils underlain by dense glacial till.

The Marblemount soil is moderately deep and well drained. It formed in volcanic ash, glacial till, and colluvium derived dominantly from granite. Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer, where mixed to a depth of 6 inches, is dark brown very stony sandy loam. The subsoil is dark yellowish brown very stony loamy sand 11 inches thick. The substratum is light yellowish brown very stony loamy sand 7 inches thick. Weathered granite is at a depth of 24 inches. Depth to weathered granite ranges from 20 to 40 inches. In some areas the surface layer is very gravelly sandy loam, and in some areas the subsoil very cobbly coarse sand.

Permeability of the Marblemount soil is moderately rapid. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of hard and mostly unweathered granite. It occurs as steep cliffs and irregular formations.

The Marblemount soil in this unit is used as woodland.

Western hemlock and Douglas fir are the main woodland species on the Marblemount soil. On the basis of a 100-year site curve. the mean site index is estimated to be 117 for western hemlock and 129 for Douglas fir. On the basis of a 50-year site curve, the mean site index is estimated to be 85 for western hemlock and 107 for Douglas fir. The highest average growth rate is 174 cubic feet per acre per year for western hemlock at age 50 and 128 cubic feet per acre per year for Douglas fir at age 70. The areas of Rock outcrop make up about 25 percent of this unit and limit yields accordingly. Among the trees of limited extent are Pacific silver fir and western redcedar. Common forest understory plants are western swordfern, salal, Pacific trillium. Oregongrape, northern twinflower, red huckleberry, and maidenhair.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. Cable yarding

systems generally are used on this unit. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Rock outcrop hinders harvesting operations. Occasional snowpack hinders the use of equipment and limits access in winter. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Establishing plant cover on steep cuts and fills reduces erosion. Following road construction and clearcutting, road failures and landslides are likely to occur.

The hazards of windthrow and seedling mortality are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs readily. The low available water capacity of the soil during the growing season and droughtiness of the surface layer result in a high mortality rate of seedlings. The areas of Rock outcrop limit the even distribution of reforestation. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIIs.

92-Minkler silt loam. This very deep, moderately well drained soil is on river terraces. It formed in old alluvial and lacustrine material. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 50 to 80 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 50 degrees F. and the average frost-free season is 160 to 210 days.

Typically, the surface layer is dark grayish brown silt loam 12 inches thick. The subsoil is olive gray silt loam 3 inches thick. The substratum to a depth of 60 inches or more is dark gray and gray, stratified loamy fine sand to very fine sandy loam. In some areas the surface layer is fine sandy loam or loam.

Included in this unit are some soils that have a sandy substratum and are well drained, some poorly drained soils that are high in content of talc and are overlain by sand, and some poorly drained soils that are silty. Also included are small areas of soils that are subject to flooding.

Permeability of this Minkler soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 6 to 30 inches from November to April. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare periods of flooding.

This unit is used as cropland, hayland, pastureland,, and homesites.

This unit is suited to all crops commonly grown in the survey area (fig. 3). Artificial drainage permits field operations to be conducted earlier and increases yields of perennial crops. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, 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. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

Common forage plants on this unit are perennial grasses, legumes, oats, and corn. Applying animal manure and returning crop residue to the soil help to maintain organic matter content, fertility, and tilth. Animal manure can be properly applied on grass-legume crops periodically during the growing season.

If this unit is used for homesite development, the main limitations are wetness and the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Tile drainage can be used to lower the water table if suitable outlets are available. Roads and buildings should be located above the expected flood level. Septic tank absorption fields do not function properly because of wetness. Effluent from the absorption fields may contaminate ground water. Community sewage systems commonly are needed.

This unit has potential for use as woodland. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 167. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 125. The potential highest average growth rate for Douglas fir is 178 cubic feet per acre per year at age 60. Trees of limited extent include red alder and western redcedar. Common forest understory plants include holly, blackberry, red elderberry, vine maple, and western swordfern.

This map unit is in capability subclass IIw.

93-Montborne very gravelly loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is on glaciated mountainsides. It formed in volcanic ash and glacial till. The native vegetation is mainly conifers. Elevation is 1,200 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F. and the average frost-free season is 120 to 140 days.

Typically, the surface is covered with a mat of

Figure 3.-Potatoes in an area of Minkler silt loam.

needles, leaves, and twigs 3 inches thick. The surface layer, where mixed to a depth of 6 inches, is reddish brown very gravelly loam. The upper 12 inches of the subsoil is reddish brown and dark brown extremely gravelly loam, and the lower 4 inches is dark yellowish brown extremely gravelly loam. The substratum is yellowish brown extremely gravelly loam about 10 inches thick. Light brownish gray, dense glacial till that crushes to very gravelly loam is at a depth of about 32 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the profile is less than 35 percent rock fragments.

Included in this unit are small areas of Crinker soils, Rinker soils, and deep colluvial soils that are high in content of phyllite. Also included are small areas of Rock outcrop.

Permeability of this Montborne soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 18 to 36 inches from December to April.

This unit is used as woodland.

Western hemlock and Douglas fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 147 for western hemlock and 146 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 105 for western hemlock and 114 for Douglas fir. The highest average growth rate is 232 cubic feet per acre per year for western hemlock at age 50 and 153 cubic feet per acre per year for Douglas fir at age 60. Among the trees of limited extent are western redcedar, Pacific silver fir,

red alder, and bigleaf maple. Common forest understory plants are vine maple, western brackenfern, western swordfern, trailing blackberry, and tall blue huckleberry.

The main limitation for the harvesting of timber is steepness of slope. 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. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIe.

94-Montborne very gravelly silt loam, 3 to 30 percent slopes. This moderately deep, moderately well drained soil is on glaciated mountainsides. It formed in volcanic ash and glacial till, The native vegetation is mainly conifers. Elevation is 1,200 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 140 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer. where mixed to a depth of 6 inches is brown very gravelly silt loam. The upper 12 inches of the subsoil is strong brown very gravelly silt loam, and the lower 10 inches is brown very gravelly silt loam. The substratum is yellowish brown extremely gravelly loam about 10 inches thick. Dense glacial till that crushes to very gravelly loam is at a depth of about 38 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the profile is less than 35 percent rock fragments.

Included in this unit are small areas of Crinker soils, Rinker soils, and deep colluvial soils that are high in content of phyllite. Also included are small areas of Rock outcrop.

Permeability of this Montborne soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the dense glacial till at a depth of 18 to 36 inches from December to April.

This unit is used as woodland.

Western hemlock and Douglas fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 147 for western hemlock and 146 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 105 for western hemlock and 114 for Douglas fir. The highest average growth rate is 232 cubic feet per acre per year for western hemlock at age 50 and 153 cubic feet per acre per year for Douglas fir at age 60. Among the trees of limited extent are western redcedar, Pacific silver fir, red alder, and bigleaf maple. Common forest understory plants are vine maple, western brackenfern, western swordfern, trailing blackberry, and tall blue huckleberry.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Soil wetness limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be reduced by careful use of wheeled and tracked equipment. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. 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 can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass IVe.

95-Montborne-Rinker complex, 30 to 65 percent slopes. This map unit is on glaciated mountainsides. The native vegetation is mainly conifers. Elevation is 1,200 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 140 days.

This unit is about 60 percent Montborne very gravelly loam and about 25 percent Rinker very channery 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 Wollard soils, soils that are less than 20 inches deep to phyllite, deep colluvial soils that are high in content of phyllite and are on high mountainsides, and Rock outcrop.

The Montborne soil is moderately deep and moderately well drained. It formed in volcanic ash and glacial till derived dominantly from phyllite. Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer, where mixed to a depth of 6 inches, is dark reddish brown very gravelly loam. The upper 12 inches of the subsoil is reddish brown and dark brown extremely gravelly loam, and the lower 4 inches is dark yellowish brown extremely gravelly loam. The substratum is yellowish brown extremely gravelly loam about 10 inches thick. Light brownish gray, dense glacial till that crushes to very gravelly loam is at a depth of about 32 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the profile is less than 35 percent rock fragments.

Permeability of the Montborne soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium. and the hazard of water erosion is moderate. A perched water table is at a depth of 18 to 36 inches from December to April.

The Rinker soil is moderately deep and well drained. It formed in volcanic ash and colluvium derived dominantly from phyllite. Typically, the surface is covered with a mat of needles and twigs 5 inches thick. The surface layer. where mixed to a depth of 7 inches, is brown very channery loam. The subsoil is dark yellowish brown very channery loam 11 inches thick. The substratum is light yellowish brown extremely channery silt loam 11 inches thick. Phyllite is at a depth of 29 inches. Depth to phyllite ranges from 20 to 40 inches. In some areas the profile is moderately deep to dense glacial till.

Permeability of this Rinker 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.

This unit is used as woodland.

Western hemlock and Douglas fir are the main woodland species on the Montborne soil. On the basis of a 100-year site curve, the mean site index is 147 for western hemlock and 146 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 105 for western hemlock and 114 for Douglas fir. The highest average growth rate is 232 cubic feet per acre per year for western hemlock at age 50 and 153 cubic feet per acre per year for Douglas fir at age 60. Among the trees of limited extent are western redcedar, Pacific silver fir, red alder, and bigleaf maple. Common forest understory plants are vine maple, western brackenfern, western swordfern, trailing blackberry, and tall blue huckleberry.

Western hemlock and Douglas fir are the main woodland species on the Rinker soil. On the basis of a 100-year site curve, the mean site index is 157 for western hemlock and 146 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 110 for western hemlock and 107 for Douglas fir. The highest average growth rate is 249 cubic feet per acre per year for western hemlock at age 50 and 153 cubic feet per acre per year for Douglas fir at age 60. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Common forest understory plants are salal, Oregongrape, western swordfern, western brackenfern, and vine maple.

The main limitation for the harvesting of timber is steepness of slope. 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. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by plant cover or adequate water bars are provided.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber on this unit. Reforestation can be accomplished by planting western hemlock and Douglas fir seedlings. If seed trees are present. natural reforestation of cutover areas by western hemlock occurs periodically. Natural reforestation by Pacific silver fir occurs periodically on the Montborne soil. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIe.

96-Mt. Vernon very fine sandy loam. This very deep. moderately well drained soil is on flood plains. It formed in recent alluvium with an admixture of volcanic ash. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 10 to 50 feet. The average annual precipitation is about 32 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface layer is dark brown very fine sandy loam 10 inches thick. The upper 19 inches of the underlying material is dark yellowish brown and grayish brown. stratified very fine sandy loam, fine sandy loam, loamy fine sand, and fine sand, and the lower part to a depth of 60 inches or more is grayish brown and olive gray, stratified silt loam, very fine sandy loam, fine sandy loam, loamy fine sand, and fine sand. In some areas the surface layer is sandy loam or silt loam, and in some areas the surface layer is not dark colored.

Included in this unit are small areas of soils that are underlain by a layer of sand 10 inches thick or more and soils that are silty throughout and are on flood plains. Also included are small areas of Mt. Vernon soils that have slopes of more than 3 percent and soils that are poorly drained and are in swales.

Permeability of this Mt. Vernon 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 water table has been lowered by drainage of adjacent lowland areas. A seasonal high water table is at a depth of 24 to 48 inches from November to April. This soil is subject to occasional, brief periods of flooding from November to April.

This unit is used as cropland, pastureland, hayland, and homesites.

The main limitation for use of this unit as cropland is the hazard of flooding. Flooding can be controlled by use of dikes. This unit is suited to all crops commonly grown in the survey area. Artificial drainage permits field operations to be conducted earlier and increases yields of perennial crops. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, fertility, and tilth. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Crusting of the surface and compaction of the soil can be reduced by returning crop residue to the soil and by using minimum tillage.

Common forage plants on this unit are perennial grasses. legumes, oats, and corn. Applying animal manure and returning crop residue to the soil help to maintain organic matter content, fertility, and tilth. Animal manure can be properly applied on grass-legume crops periodically during the growing season.

This unit has potential for use as woodland.

On the basis of a 100-year site curve. the mean site index for Douglas fir is estimated to be 174. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 130. The potential highest average growth rate for Douglas fir is 185 cubic feet per acre per year at age 60. Among the trees of limited extent are bigleaf maple, western redcedar, western hemlock, and red alder. Common forest understory plants are western swordfern, ladyfern, western brackenfern, trailing blackberry, Oregongrape, salal, and geranium.

If this unit is used for homesite development, the main limitations are the hazard of flooding and the seasonal high water table. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Tile drainage can be used to lower the water table if suitable outlets are available. Septic tank absorption fields do not function properly because of wetness. Effluent from the absorption fields may contaminate ground water. Community systems commonly are needed. Roads and streets should be located above the expected flood level.

This map unit is in capability subclass IIw.

97-Mukilteo muck. This very deep, very poorly drained soil is in depressional areas. It formed in decomposed sedges, mosses, shrubs, and grasses. Slope is 0 to 1 percent. The native vegetation is mainly sedges, mosses, shrubs, and grasses. Elevation is 50 to 1,000 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface tier is black muck 5 inches thick. The upper 43 inches of the underlying tier is dark reddish brown hemic or sapric material, and the lower part to a depth of 60 inches or more is black sapric material. In some areas the surface tier is dark reddish brown organic material.

Included in this unit are small areas of soils that are underlain by mineral soil material.

Permeability of this Mukilteo soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at or above the surface from October to May. Runoff is ponded, and the hazard of water erosion is none.

Most areas of this unit are used as wildlife habitat. A

few areas are used as pastureland and woodland.

The main limitation for pasture is wetness. Tile drains and open drains 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 during the growing season and is allowed to return to the surface during the winter. Wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Red alder is the main woodland species on this unit. On the basis of a 50-year site curve, the mean site index for red alder is 87. The highest average growth rate for red alder is 96 cubic feet per acre per year at age 40. Common forest understory plants are salmonberry, red elderberry, ladyfern, devilsclub, and trillium.

The main limitation for the harvesting of timber is the muddiness caused by seasonal soil wetness. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table and ponding limit the use of equipment to dry periods.

The hazard of windthrow and seedling establishment are the main concerns for the production of timber. Reforestation can be accomplished by planting red alder. 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 can prevent the establishment of seedlings. The seasonal high water table reduces root respiration, which results in a low survival rate of seedlings. Because rooting depth is restricted by the seasonal high water table, trees frequently are subject to windthrow.

This map unit is in capability subclass Vw.

98-Mukilteo Variant muck. This very deep, poorly drained soil is in backswamps and low areas of flood plains. Drainage has been partially altered by using tile drains and open ditches. The soil formed in decomposed organic matter over clayey alluvium. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly shrubs and water-tolerant hardwoods and conifers. Elevation is 10 to 200 feet. The average annual precipitation is about 30 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface tier is black muck about 9 inches thick. The next 13 inches is black sapric material. Below this to a depth of 60 inches or more is greenish gray silty clay. Depth to mineral material ranges from 16 to 50 inches.

Included in this unit are small areas of Bellingham mucky silt loam, Snohomish silt loam, Sumas silt loam, and soils that are very deep to mineral soil material.

Permeability of this Mukilteo Variant soil is moderate in the organic material and slow in the clayey underlying material. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at the surface to a depth of 18 inches below the surface from December to March. Runoff is slow, and the hazard of water erosion is slight. Flooding typically is rare in areas protected by dikes; however, this soil is subject to occasional, long periods of flooding in areas not protected by dikes.

This unit is used mainly as cropland. A few areas are used as hayland, pastureland, and woodland.

The main limitation of this unit for use as cropland is the seasonal high water table. Most crops common to the area can be grown in areas where the soil is drained by tiling or open ditches. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Subsidence is minimized if the water table is maintained immediately below the root zone during the growing season and is allowed to return to the surface during the winter.

Common forage plants on this unit are perennial grasses, legumes, oats, and corn. Applying animal manure and returning crop residue to the soil help to maintain fertility. Animal manure can be properly applied on grass-legume crops periodically during the growing season. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Red alder is the main woodland species on this unit. On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 90. The highest average growth rate for red alder is 101 cubic feet per acre per year at age 40. Among the trees of limited extent is western redcedar. Common forest understory plants are willow, hardhack, rushes, black cottonwood, and skunkcabbage.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. The seasonal high water table and flooding limit the use of equipment to dry periods.

The hazard of windthrow and seedling establishment are the main concerns in the production of timber.

Reforestation can be accomplished by planting red alder or western redcedar. 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 can prevent the establishment of seedlings. The seasonal high water table reduces root respiration, which results in a low survival rate of seedlings. Because rooting depth is restricted by the seasonal high water table, trees frequently are subject to windthrow.

This map unit is in capability subclass IIw.

99-Mundt silt loam, 45 to 75 percent slopes. This very deep, moderately well drained soil is on dissected canyonsides. It formed in glaciolacustrine sediment. The native vegetation is mainly conifers. Elevation is 400 to 1,100 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 47 degrees F, and the average frost-free season is 160 to 180 days.

Typically, the surface is covered with a mat of leaves and twigs 0.5 inch thick. The surface layer is dark brown and olive silt loam 6 inches thick. The subsoil is olive silt loam 26 inches thick. The substratum to a depth of 60 inches or more is olive silt loam. In some areas the substratum is clayey.

Included in this unit are small areas of Oakes and Sorensen soils on low mountains, Barneston soils on outwash terraces, and Rock outcrop.

Permeability of this Mundt soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 24 to 36 inches from December to March. Runoff is rapid, and the hazard of water erosion is severe.

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 for Douglas fir is estimated to be 160. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 120. The highest average growth rate for Douglas fir is 170 cubic feet per acre per year at age 65. Among the trees of limited extent are western hemlock, western redcedar, red alder, and bigleaf maple. Common forest understory plants are western swordfern, salal, trailing blackberry, red elderberry. and vine maple.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. Cable yarding systems generally are used on this unit. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills 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 they are protected by plant cover or adequate water bars are provided. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Seedling establishment and the hazard of windthrow are the main concerns 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 by western hemlock it occurs periodically. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Because the rooting depth is restricted by the perched water table, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIIe.

100-Nargar loam, 0 to 8 percent slopes. This very deep, well drained soil is on terraces. It formed in alluvium, loess. and volcanic ash. The native vegetation is mainly conifers. Elevation is 50 to 900 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. The surface layer is dark brown loam 3 inches thick. The subsoil is strong brown and dark yellowish brown loam 30 inches thick. The substratum to a depth of 60 inches or more is light olive brown sand. Depth to sand ranges from 15 to 35 inches. In some areas the surface layer is gravelly sandy loam or fine sandy loam.

Included in this unit are some areas of Barneston, Birdsview. and Winston soils on terraces. Also included are small areas of Nargar soils that have slopes of more than 8 percent and soils that are moderately well drained.

Permeability of this Nargar soil is moderate to the substratum and moderately rapid through it. Available water capacity is moderately high to high. Effective

rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. A few areas are used as cropland, hayland, pastureland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 177. On the basis of a 50-year site curve, the mean site index for Douglas fir is 134. The highest average growth rate for Douglas fir is 188 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Common forest understory plants are western swordfern. red huckleberry, ladyfern, vine maple. salal, deer fern, salmonberry, western brackenfern, and trailing blackberry.

The main limitation for the harvesting of timber is the muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts. compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not 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 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 red alder occurs readily and by western hemlock it occurs periodically. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings.

The main limitations of this unit for use as cropland are the hazard of erosion and droughtiness in summer. This unit is suited to all crops commonly grown in the survey area. Returning all crop residue to the soil and using cover crops help to control erosion, to conserve soil moisture, and to maintain organic matter content, fertility, and tilth. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

Common forage plants on this unit are perennial grasses. legumes, oats, and corn. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Applying animal manure and returning crop residue to the soil help to maintain organic matter content, fertility, and tilth. Animal manure can be properly applied on grass-legume crops periodically during the growing season.

This unit is well suited to homesite development. The main limitation for septic tank absorption fields is the risk of 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 IIe.

101-Nookachamps silt loam. This very deep, poorly drained soil is on flood plains. Drainage has been altered by tiling. The soil formed in alluvium derived from phyllite and lacustrine material. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly mixed hardwoods and conifers. Elevation is 45 to 250 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface layer is olive brown silt loam 9 inches thick. The subsoil is gray silt loam 23 inches thick, The substratum to a depth of 60 inches or more is gray silt loam. In some areas the surface layer is silty clay loam, and in some areas the substratum has lenses of peat or muck.

Included in this unit are areas of Mukilteo Variant soils, Sumas soils, and moderately well drained soils on flood plains. Also included are small areas of Wickersham soils on alluvial fans and Nookachamps soils that are only partially drained or are not drained.

Permeability of this Nookachamps 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 6 to 18 inches from November to March; drainage is used to lower the water table during the growing season. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, brief periods of flooding from December to April.

This unit is used as hayland, pastureland, and wildlife habitat.

The main limitations of this unit for hay and pasture are the seasonal high water table and the hazard of flooding. The water table limits the use of this unit to annual crops, grasses, and shallow-rooted legumes. Some areas of the unit have been partially drained, but adequate drainage systems have not been maintained. Flooding can be controlled by use of dikes. Returning all crop residue to the soil and using cover crops help to conserve soil moisture and to maintain organic matter content, fertility, and tilth. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Applying animal manure and returning crop residue to

the soil help to maintain organic matter content, fertility, and tilth. Animal manure can be properly applied on grass-legume crops periodically during the growing season. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit has potential for use as woodland. On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 80. The potential highest average growth rate for red alder is 84 cubic feet per acre per year at age 40. The trees of limited extent include western redcedar, western hemlock, and Sitka spruce. Common forest understory plants include sweetscented bedstraw, salmonberry, devilsclub, vine maple, ladyfern, western swordfern, red huckleberry, and skunkcabbage.

This map unit is in capability subclass IIIw.

102-Norma silt loam. This very deep, poorly drained soil is in drainageways and depressional areas. It formed in alluvium. Slope is 0 to 3 percent. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 50 to 1,000 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface layer is very dark gray and very dark grayish brown silt loam 11 inches thick. The upper 12 inches of the subsoil is dark grayish brown loam, and the lower 22 inches is dark grayish brown gravelly sandy loam. The substratum to a depth of 60 inches or more is dark grayish brown and very dark grayish brown very gravelly sandy loam. In some areas the surface layer is mucky loam.

Included in this unit are small areas of Cathcart, Tokul, and Vanzandt soils on hills and Bellingham and Mukilteo soils in depressional areas.

Permeability of this Norma soil is moderately rapid. Available water capacity is moderately high to high. Effective rooting depth is limited by a seasonal high water table that is above or near the surface from November to April. Runoff is ponded, and the hazard of water erosion is slight. This soil is subject to ponding from November to April.

This unit is used mainly as woodland. Some areas are used as pastureland and hayland.

Red alder is the main woodland species on this unit. On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 90. The highest average growth rate for red alder is 101 cubic feet per acre per year at age 40. Among the trees of limited extent are western redcedar, bigleaf maple, and western hemlock. Common forest understory plants are skunkcabbage, stinging nettle, salmonberry, red huckleberry, cascara buckthorn, and willow.

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

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 red alder occurs periodically. Reforestation can be accomplished by planting western redcedar seedlings. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Seasonal soil wetness and ponding reduce root respiration, which results in a low survival rate of seedlings. Because the rooting depth is restricted by the seasonal high water table, trees frequently are subject to windthrow.

The main limitation of this unit for use as pastureland or hayland is the seasonal high water table. Tile drains and open drains can be used to lower the water table 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. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This map unit is in capability subclass VIw.

103-Oakes gravelly silt loam, 30 to 65 percent slopes. This deep, well drained soil is on glacially modified mountainsides. It formed in colluvium derived from andesite and argillite containing glacial till and volcanic ash. The native vegetation is mainly conifers. Elevation is 1,000 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 140 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly silt loam 3 inches thick. The subsoil is dark brown, yellowish brown, and dark yellowish brown very gravelly loam 39 inches thick. The substratum is olive brown very gravelly loam about 8 inches thick. Argillite is at a depth of about 50 inches.

Depth to bedrock ranges from 40 to 60 inches. In some areas the profile is very deep.

Included in this unit are small areas of Montborne soils that are 20 to 40 inches deep to bedrock and small areas of Rock outcrop.

Permeability of this Oakes soil is moderate. Available water capacity is moderate to high. Effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used 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 estimated to be 152 for Douglas fir and 148 for western hemlock. On the basis of a 50-year site curve, the mean site index is estimated to be 117 for Douglas fir and 105 for western hemlock. The highest average growth rate is 161 cubic feet per acre per year for Douglas fir at age 60 and 234 cubic feet per acre per year for western hemlock at age 50. Among the trees of limited extent are western redcedar and red alder. Common forest understory plants are western swordfern, western brackenfern, Oregongrape, trailing blackberry, and tall blue huckleberry.

The main limitation for the harvesting of timber is steepness of slope. 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. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by plant cover or adequate water bars are provided.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs periodically. When openings are made in the canopy. invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIe.

104-Pilchuck loamy sand. This very deep, excessively drained soil is on flood plains. It formed in sandy alluvium. Slopes are 0 to 3 percent. The native vegetation is mainly mixed hardwoods and conifers with an understory of shrubs. Elevation is 20 to 500 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface layer is dark grayish brown loamy sand 3 inches thick. The upper 40 inches of the underlying material is dark grayish brown fine sand and sand, and the lower part to a depth of 60 inches or more is very dark grayish brown gravely sand. In some areas the surface layer is sandy loam. In some small areas the underlying material is very gravelly.

Included in this unit are small areas of Greenwater and Nargar soils on outwash terraces and small areas of Riverwash.

Permeability of this Pilchuck soil is rapid. Available water capacity is low to moderate. 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, during periods when the water level of the river is high. This soil is subject to frequent, brief periods of flooding from November to April.

This unit is used mainly as woodland. A few areas are used as pastureland.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 152. On the basis of a 50-year site curve, the mean site index for Douglas fir is 114. The highest annual growth rate for Douglas fir is 161 cubic feet per acre per year at age 60. Among the trees of limited extent are black cottonwood, red alder, and bigleaf maple. Common forest understory plants are vine maple, western swordfern, salmonberry, common snowberry, false Solomons seal, and stinging nettle.

The main limitation for the harvesting of timber is soil wetness as a result of seasonal flooding. Seasonal flooding limits the use of equipment to dry 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 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, black cottonwood, and bigleaf maple occurs readily. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. The survival rate of seedlings may be low in areas where frequent flooding occurs. The droughtiness of the surface layer reduces the survival rate of seedlings.

This unit is limited for pasture by droughtiness. In summer irrigation is needed for maximum production. Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This map unit is in capability subclass IVw.

105-Pilchuck Variant fine sandy loam. This very deep, moderately well drained soil is on terraces and levees. It formed in alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 10 to 50 feet. The average annual precipitation is about 30 inches, the average annual air temperature is about 50 degrees F. and the average frost-free season is 170 to 220 days.

Typically. the surface layer is dark brown fine sandy loam 8 inches thick. The upper 24 inches of the underlying material is grayish brown and dark gray, stratified loamy fine sand and fine sand with thin strata of very fine sandy loam, and the lower part to a depth of 60 inches or more is gray fine sand. In some small areas the surface layer is 10 inches thick or more, and in some areas the profile has properties associated with weathered volcanic ash and is underlain by sandy or loamy material.

Permeability of this Pilchuck Variant soil is moderately rapid. Available water capacity is moderate to moderately high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 48 to 60 inches from November to April. The water table has been lowered by drainage of adjacent lowland areas. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, brief periods of flooding from November to April.

This unit is used mainly as cropland, hayland, and pastureland. Some areas are used as homesites.

The main limitations of this unit for use as cropland are droughtiness and the hazard of flooding. Flooding can be controlled by use of dikes. This unit is suited to all crops commonly grown in the survey area. Returning all crop residue to the soil and using cover crops help to conserve soil moisture and to maintain organic matter content, fertility, and tilth. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

If this unit is used for hay and pasture, the main limitations are droughtiness and the hazard of flooding. Flooding can be controlled by use of dikes. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. In summer supplemental irrigation is required for maximum production.

This unit has potential for use as woodland. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 153. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 115. The potential highest average growth rate for Douglas fir is 162 cubic feet per acre per year at age 60. Trees of limited extent include red alder. black cottonwood, and bigleaf maple. Common forest understory plants include vine maple, western swordfern, salmonberry, stinging nettle, western brackenfern, and false Solomons seal.

The main limitation of this unit for use as homesites is the hazard of flooding. The main limitations for septic tank absorption fields are the hazard of flooding and the poor filtering capacity of the soil. Adequate construction and proper maintenance of dikes reduce 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.

This map unit is in capability subclass IVw.

106-Pits. This map unit consists of areas that have been excavated for sand, gravel, or hard rock. Areas are 4 to 100 acres in size.

Included in this unit are small areas of soils that have not been excavated, areas used as dump sites that are partially filled, and small ponds where material has been excavated below the water table.

The water table is at the surface to a depth of more than 5 feet below the surface. Permeability and available water capacity are variable. Surface runoff is very rapid to ponded.

Most areas of this unit are used as wildlife habitat or are still being mined. Some areas are used for recreation. The potential is poor for use as cropland, pastureland, and woodland. Areas are too variable to be rated according to their potential for recreational and engineering uses. Onsite evaluation is needed.

This map unit is in capability subclass VIIIs.

107-Rinker very channery loam, 30 to 65 percent slopes. This moderately deep.. well drained soil is on glaciated mountainsides. It formed in volcanic ash, glacial till, and colluvium derived from phyllite. The native vegetation is mainly conifers, Elevation is 1,000 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 150 days.

Typically, the surface is covered with a mat of

needles, leaves, and twigs 5 inches thick. The surface layer., where mixed to a depth of 7 inches, is brown very channery loam. The subsoil is dark yellowish brown very channery loam 11 inches thick. The substratum is light yellowish brown extremely channery silt loam about 11 inches thick. Phyllite is at a depth of about 29 inches. Depth to phyllite ranges from 20 to 40 inches. In some areas the profile is moderately deep to dense glacial till.

Included in this unit are some soils that are less than 20 inches deep to bedrock and small areas of Rock outcrop.

Permeability of this Rinker soil is moderate. Available water capacity is low to moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland and wildlife habitat.

Western hemlock and Douglas fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 157 for western hemlock and 146 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 110 for western hemlock and 107 for Douglas fir. The highest average growth rate is 249 cubic feet per acre per year for western hemlock at age 50 and 153 cubic feet per acre per year for Douglas fir at age 60. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Common forest understory plants are salal. Oregongrape, western swordfern, western brackenfern, and vine maple.

The main limitation for the harvesting of timber is steepness of slope. 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. 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 cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs periodically. Seedlings planted in the less fertile subsoil exhibit poor growth and vigor. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by bedrock, trees occasionally are subject to windthrow.

This map unit is in capability subclass Vle.

108-Riverwash. This map unit is on active river bottom lands that are frequently flooded. Areas are 4 to 200 acres in size. Most areas are not vegetated, but some areas support scattered shrubs, grasses, and small trees. Elevation is 10 to 400 feet. The average annual precipitation is 30 to 90 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 220 days.

Typically. the areas of Riverwash consist of stratified cobbles, pebbles, silt, and sand to a depth of 60 inches or more.

Included in this unit are small areas of Pilchuck soils on flood plains and Snoqualmie soils and Xerorthents on low terraces.

Permeability is very rapid. Available water capacity is very low. Runoff is slow.

This unit is used mainly as wildlife habitat and recreation. The potential is very poor for use as cropland, pastureland, or woodland.

This map unit is in capability subclass VIIIw.

109-Rock outcrop. This map unit is on mountainsides and ridgetops. Slope is 50 to 100 percent or more. Areas are irregular in shape and are 5 to 30 acres in size. Elevation is near sea level to 4,500 feet.

Typically, the areas of Rock outcrop consist of exposures of argillite, phyllite, granite, or metasedimentary rock. Runoff is rapid.

This map unit is in capability subclass VIIIs.

110-Rubble land. This map unit is on talus slopes at the base of areas of Rock outcrop. Slope is 30 to 100 percent. The native vegetation is mainly sparse huckleberry, fireweed, and grasses. Elevation is 3,000 to 4,500 feet. The annual precipitation ranges from 60 to 90 inches, the average annual air temperature is about 43 degrees F, and the frost-free season is 90 to 130 days.

Typically, the areas of Rubble land consist of loosely piled angular stones and boulders to a depth of 60 inches or more.

Included in this unit are small areas that have soil material at a depth of less than 60 inches. Also included are small areas of Rock outcrop.

Permeability is very rapid. Available water capacity is very low. Runoff is slow.

This unit is used as wildlife habitat.

This map unit is in capability subclass VIIIs.

111-Saar gravelly silt loam, 3 to 30 percent slopes. This moderately deep, moderately well drained soil is on glacially modified mountainsides. It formed in volcanic ash, colluvium, and glacial till. The native vegetation is mainly conifers. Elevation is 3,100 to 4,500 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 39 degrees F, and the average frost-free season is 90 to 110 days.

Typically, the surface is covered with a mat of needles and twigs 9 inches thick. The surface layer, where mixed to a depth of 6 inches, is reddish brown gravelly silt loam. The upper 9 inches of the subsoil is dark reddish brown and dark brown very gravelly loam, and the lower 8 inches is dark yellowish brown very gravelly loam. Light olive brown, dense glacial till that crushes to extremely gravelly sandy loam is at a depth of about 23 inches. Depth to dense glacial till ranges from 20 to 40 inches.

Included in this unit are small areas of Clendenen, Humskel, and Kindy soils on mountainsides. Also included are small areas of Rock outcrop.

Permeability of this Saar soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the dense glacial till at a depth of 18 to 36 inches from November to May.

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 for western hemlock is estimated to be 105. On the basis of a 50-year site curve, the mean site index for western hemlock is estimated to be 75. The highest average growth rate for western hemlock is 151 cubic feet per acre per year at age 60. Among the trees of limited extent are Pacific silver fir, mountain hemlock, and western redcedar. Common forest understory plants are currant.. tall blue huckleberry, clubmoss, deer fern, and queencup beadlily.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Winter snowpack limits the use of equipment and restricts access.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Low soil temperature in summer, deep snowpack, and a short growing season reduce the survival rate of planted and natural seedlings and delay their establishment. Because the rooting depth is restricted by the dense glacial till, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIe.

112-Saar gravelly silt loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is on glacially modified mountainsides. It formed in volcanic ash, colluvium, and glacial till. The native vegetation is mainly conifers. Elevation is 3,100 to 4,500 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 39 degrees F, and the average frost-free season is 90 to 110 days.

Typically, the surface is covered with a mat of needles and twigs 4 inches thick. The surface layer, where mixed to a depth of 6 inches is brown gravelly silt loam. The upper 6 inches of the subsoil is reddish brown gravelly silt loam, the next 6 inches is strong brown very gravelly silt loam, and the lower 8 inches is yellowish brown very gravelly loam. Light olive brown, dense glacial till that crushes to extremely gravelly loam is at a depth of about 26 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the surface layer is very gravelly silt loam or very gravelly loam.

Included in this unit are small areas of Clendenen, Humskel, and Kindy soils on mountains. Also included are small areas of Rock outcrop and Rubble land.

Permeability of this Saar soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 18 to 36 inches from November to May.

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 for western hemlock is estimated to be 105. On the basis of a 50-year site curve, the mean site index for western hemlock is estimated to be 75. The highest average growth rate for western hemlock is 151 cubic feet per acre per year at age 60. Among the trees of limited extent are Pacific silver fir, mountain hemlock,

and western redcedar. Common forest understory plants are currant, tall blue huckleberry, clubmoss, deer fern. and queencup beadlily.

The main limitation for the harvesting of timber is steepness of slope. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided. Winter snowpack limits the use of equipment and restricts access.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Low soil temperature in summer, deep snowpack,, and a short growing season reduce the survival rate of planted and natural seedlings and delay their establishment. Because the rooting depth is restricted by the dense glacial till, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIe.

113-Saar Variant very stony loamy sand, 30 to 65 percent slopes. This very deep, well drained soil is on glaciated mountainsides. It formed in volcanic ash and glacial till influenced by granite. The native vegetation is mainly conifers. Elevation is 2,200 to 4,000 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 38 degrees F, and the average frost-free season is 85 to 110 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 11 inches thick. The surface layer is brown very stony loamy sand 4 inches thick. The upper 8 inches of the subsoil is dark reddish brown very stony silt loam, and the lower 12 inches is strong brown and dark yellowish brown very stony sandy loam. The substratum is olive brown very stony sandy loam 12 inches thick. Below this to a depth of 60 inches or more is light olive brown, weakly compacted glacial till that crushes to very stony loamy sand. In some areas the surface layer is very stony sandy loam.

Included in this unit are some soils that have dense glacial till or granite at a depth of 20 to 40 inches and some soils that have a very cobbly sand subsoil. Also included are small areas of Rubble land and Rock outcrop.

Permeability of this Saar Variant soil is moderately slow. Available water capacity is low to moderately high. 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 for western hemlock is 90. On the basis of a 50-year site curve, the mean site index for western hemlock is 60. The highest average growth rate for western hemlock is 105 cubic feet per acre per year at age 60. Among the trees of limited extent is Pacific silver fir. Common forest understory plants are bunchberry dogwood, salmonberry, deer fern, northern twinflower, and tall blue huckleberry.

The main limitation for the harvesting of timber is steepness of slope. 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. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Material cast to the side ravels and commonly sloughs when saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided. Winter snowpack limits the use of equipment and restricts access.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Seedlings planted in the less fertile subsoil exhibit poor growth and vigor. The droughtiness of the surface layer reduces the survival rate of seedlings, especially on south- and southwest-facing side slopes. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIs.

114-Samish silt loam. This very deep, somewhat poorly drained soil is on stream terraces. Drainage has been partially altered by use of tile and open ditches. The soil formed in alluvium derived from phyllite and talc. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly mixed hardwoods and conifers. Elevation is 45 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 160 to 200 days.

Typically, the surface layer is dark gray silt loam 8 inches thick, The upper 15 inches of the underlying material is gray silt loam. and the lower part to a depth of 60 inches or more is dark gray and greenish gray. stratified very fine sandy loam and silt loam.

Included in this unit are some soils that have a sandy underlying material, soils that are silt throughout, and soils that are not artificially drained. Also included are small areas of Mukilteo Variant muck in depressional areas and Wickersham soils on alluvial fans.

Permeability of this Samish soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 12 to 18 inches from November to May. Runoff is slow. and the hazard of water erosion is slight. This soil is subject to occasional. brief periods of flooding from November to April.

This unit is used as cropland., hayland, and pastureland.

The main limitations of this unit for use as cropland are the seasonal high water table and the hazard of flooding. If adequate drainage systems and dikes are used. this soil is suited to all crops commonly grown in the survey area. Protecting the unit from flooding and providing drainage facilitate timely field operations and increase yields of climatically adapted cultivated crops. Tile drains and open drains can be used to lower the water table if a suitable outlet is available. Flooding can be controlled by use of dikes. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, 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. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

Common forage plants on this unit are perennial grasses, legumes, oats, and corn. Applying animal manure and returning crop residue to the soil help to maintain organic matter content, fertility, and tilth. Animal manure can be properly applied on grass-legume crops periodically during the growing season. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

This unit has potential for use as woodland. Red alder is the main woodland species. On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 85. The potential highest average growth rate for red alder is 92 cubic feet per acre per year at age 40. The trees of limited extent include western redcedar and Sitka spruce. Common forest understory plants include salmonberry, false Solomons seal, ladyfern, western swordfern, and Indian plum.

This map unit is in capability subclass IIw.

115-Sandun very gravelly sandy loam, 30 to 65 percent slopes. This very deep, well drained soil is on glacially modified mountain foot slopes. It formed in loess, volcanic ash, and glacial till derived from dunite. The vegetation in areas not cultivated is mainly conifers. Elevation is 1,200 to 2,200 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 90 to 140 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 5 inches thick. The upper 4 inches of the subsoil is dark brown very gravelly sandy loam, and the lower 16 inches is strong brown and light olive brown very cobbly sandy loam. The upper 14 inches of the substratum is yellowish brown very cobbly coarse sandy loam, and the lower part to a depth of 60 inches or more is light olive brown very gravelly sand.

Included in this unit are some soils that are moderately deep to dunite or dense glacial till.

Permeability of this Sandun soil is moderately rapid in the subsoil and very rapid in the substratum. Available water capacity is low to moderately high. 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 for western hemlock is estimated to be 120. On the basis of a 50-year site curve, the mean site index for western hemlock is estimated to be 95. The highest average growth rate for western hemlock is 180 cubic feet per acre per year at age 50. Among the trees of limited extent are Douglas fir and red alder. Common forest understory plants are salal, red huckleberry, and western swordfern.

The main limitation for the harvesting of timber is steepness of slope. 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. Logging roads require suitable surfacing for year-round use. Rounded rock for road construction is readily available on this unit. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided.

Seedling mortality is the main concern in the production of timber. Reforestation can be accomplished by planting western hemlock or 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 rate of seedlings. Seedlings and trees on this unit exhibit poor survival, growth, and vigor.

This map unit is in capability subclass VIe.

116-Sauk silt loam. This very deep, well drained soil is on terraces. It formed in volcanic ash and alluvium. Slope is 0 to 3 percent. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 200 to 500 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 150 to 190 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer, where mixed to a depth of 6 inches, is brown silt loam. The subsoil is yellowish brown silt loam 12 inches thick. The substratum to a depth of 60 inches or more is olive brown silt loam. In some areas the surface layer is gravelly silt loam, in some areas the surface layer is dark colored and the subsoil is stratified silt and sand, and in some areas the substratum is gravelly.

Included in this unit are small areas of Pilchuck soils on flood plains. Barneston and Birdsview soils on outwash terraces. and soils that are flooded occasionally by creek overflow.

Permeability of this Sauk 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 as woodland. hayland, pastureland, cropland. and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 173. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 130. The highest average growth rate for Douglas fir is 184 cubic feet per acre per year at age 60. Among the trees of limited extent are bigleaf maple, red alder, western hemlock, and western redcedar. Common forest understory plants are Oregongrape, western brackenfern, western swordfern, and salmonberry.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. 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 red alder occurs readily and by western hemlock it occurs periodically. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings.

This unit is well 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. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is well suited to cropland. It is suited to all crops commonly grown in the survey area. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, fertility, and tilth. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Crusting of the surface and compaction of the soil can be reduced by returning crop residue to the soil and by using minimum tillage.

This unit is well suited to homesite development.

This map unit is in capability subclass IIc.

117-Saxon silt loam, 0 to 30 percent slopes. This very deep, moderately well drained soil is on terraces and hills. It formed in volcanic ash underlain by glaciolacustrine sediment. The native vegetation is mainly conifers. Elevation is 800 to 2,000 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 100 to 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 9 inches thick. The surface layer. where mixed, is pinkish gray silt loam 3 inches

thick. The subsoil is yellowish red and strong brown silt loam 6 inches thick. The upper 12 inches of the substratum is light yellowish brown silt loam, and the lower part to a depth of 60 inches or more is light gray and light olive gray silty clay loam. Depth to lacustrine sediment ranges from 8 to 20 inches. In some areas the substratum is stratified with sand and silt.

Included in this unit are small areas of soils that are underlain by cemented, dense glacial till, Oakes and Sorensen soils on low mountains, and Skykomish soils on glacial outwash terraces.

Permeability of this Saxon soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 18 to 24 inches from December to June. Runoff is slow, and the hazard of water erosion is slight.

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 for western hemlock is 152. On the basis of a 50-year site curve, the mean site index for western hemlock is 107. The highest average growth rate for western hemlock is 241 cubic feet per acre per year at age 50. Among the trees of limited extent is Douglas fir. Common forest understory plants are tall blue huckleberry, red huckleberry, princes pine, western swordfern, and deer fern.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts., compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. The perched water table limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by the perched water table., trees occasionally are subject to windthrow.

This map unit is in capability subclass IVe.

118-Sedrowoolley silt loam. This very deep, moderately well drained soil is on alluvial terraces. It formed in alluvium. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly conifers and shrubs. Elevation is 10 to 50 feet. The average annual precipitation is about 32 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface layer is dark grayish brown silt loam 10 inches thick. The underlying material to a depth of 60 inches or more is olive brown, dark grayish brown, and grayish brown, stratified very fine sandy loam and silt loam. In some areas the surface layer is fine sandy loam, and in some areas the surface layer is thick.

Included in this unit are some soils that are underlain by sandy material, soils that are protected from flooding, and soils that have slopes of more than 3 percent.

Permeability of this Sedrowoolley 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. A seasonal high water table is at a depth of 36 to 60 inches from November to May. Channeling and deposition are common along streambanks. This soil is subject to occasional, brief periods of flooding from November to April.

This unit is used as cropland, hayland, and pastureland.

The main limitation of this unit for use as cropland is the hazard of flooding. Flooding can be controlled by use of dikes. This unit is suited to all crops commonly grown in the survey area. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, 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.

Common forage plants on this unit are perennial grasses, legumes, oats, and corn. Applying animal manure and returning crop residue to the soil help to maintain organic matter content, fertility, and tilth. Animal manure can be properly applied on grass-legume crops periodically during the growing season. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

This unit has potential for use as woodland. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 174. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 130. The potential highest average growth rate for Douglas fir is 185 cubic feet per acre per year at age 60. Trees of limited extent include western redcedar, western hemlock, and red alder. Common forest understory plants include western swordfern,

western brackenfern, ladyfern, geranium, trailing blackberry, Oregongrape, and salal. This map unit is in capability subclass IIw.

119-Sehome loam, 0 to 8 percent slopes. This moderately deep, moderately well drained soil is on glaciated hills. It formed in volcanic ash and loess underlain by glacial till. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 200 to 1,100 feet. The average annual precipitation is about 55 inches. the average annual air temperature is about 51 degrees F. and the average frost-free season is 140 to 180 days.

Typically, the surface is covered with a mat of leaves and twigs 2 inches thick. The surface layer, where mixed to a depth of 6 inches, is strong brown loam. The upper 9 inches of the subsoil is strong brown loam, and the lower 13 inches is yellowish brown gravelly loam. Light olive gray, dense glacial till that crushes to gravelly loam is at a depth of about 28 inches. Depth to dense glacial till ranges from 24 to 40 inches. In some areas the surface layer is gravelly loam or gravelly silt loam.

Included in this unit are some soils that have a clayey or very gravelly sand substratum and soils that are poorly drained. Also included are small areas of soils that have slopes of more than 8 percent.

Permeability of this Sehome soil is moderate to the dense glacial till and very slow through the till. Available water capacity is moderately high and high. Effective rooting depth is 24 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the dense glacial till at a depth of 24 to 36 inches from December to April.
Most areas of this unit are used as woodland. A few areas are used as hayland, pastureland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 182. On the basis of a 50-year site curve, the mean site index for Douglas fir is 135. The highest average growth rate for Douglas fir is 193 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, red alder, western redcedar. and bigleaf maple. Common forest understory plants are salal, Oregongrape, western swordfern, vine maple, trailing blackberry, and salmon berry.

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

Seedling establishment and the hazard of windthrow are the main concerns 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. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This unit is well suited to hay and pasture. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is limited for homesite development mainly by the very slow permeability of the dense glacial till and the perched water table. Septic tank absorption fields do not function properly because of wetness and the very slow permeability. Also, effluent from the absorption fields may contaminate ground water. Community sewage systems are needed.

This map unit is in capability subclass IIe.

120-Sehome loam, 8 to 15 percent slopes. This moderately deep, moderately well drained soil is on glaciated hills. It formed in volcanic ash and loess underlain by glacial till. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 200 to 1,100 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 140 to 180 days.

Typically, the surface is covered with a mat of leaves and twigs 2 inches thick. The surface layer, where mixed to a depth of 6 inches, is strong brown loam. The upper 9 inches of the subsoil is strong brown loam, and the lower 13 inches is yellowish brown gravelly loam. Light olive gray, dense glacial till that crushes to gravelly loam is at a depth of about 28 inches. Depth to dense glacial till ranges from 24 to 40 inches. In some areas the surface layer is gravelly loam or gravelly silt loam.

Included in this unit are some soils that have a clayey or very gravelly sand substratum and soils that are poorly drained. Also included are small areas of soils that have slopes of more than 15 percent.

Permeability of this Sehome soil is moderate to the dense glacial till and very slow through the till. Available water capacity is moderately high to high. Effective rooting depth is 24 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 24 to 36 inches from December to April.

Most areas of this unit are used as woodland. A few areas are used as hayland, pastureland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 182. On the basis of a 50-year site curve, the mean site index for Douglas fir is 135. The highest average growth rate for Douglas fir is 193 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. Common forest understory plants are salal, Oregongrape, western swordfern, vine maple, trailing blackberry, and salmon berry.

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

Seedling establishment and the hazard of windthrow are the main concerns 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. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

The main limitation for hay and pasture is the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. Seedbed preparation should be on the contour or across the slope where practical. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is limited for homesite development mainly by the very slow permeability of the dense glacial till and the perched water table. Septic tank absorption fields do not function properly because of wetness and the very slow permeability. Effluent from the absorption fields may contaminate ground water. Community sewage systems are needed. This map unit is in capability subclass IIIe.

121-Sehome gravelly loam, 15 to 30 percent slopes. This moderately deep, moderately well drained soil is on glaciated hills. It formed in volcanic ash and loess underlain by glacial till. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 200 to 1,100 feet. The average annual precipitation is about 55 inches. the average annual air temperature is about 51 degrees F, and the average frost-free season is 140 to 180 days.

Typically, the surface is covered with a mat of leaves and twigs 1 inch thick. The surface layer is dark brown gravelly loam 3 inches thick. The subsoil is strong brown and yellowish brown gravelly loam 25 inches thick. Light gray, dense glacial till that crushes to gravelly loam is at a depth of about 28 inches. Depth to dense glacial till ranges from 24 to 40 inches. In some areas the surface layer is loam or silt loam.

Included in this unit are some soils that have a clayey or very gravelly sand substratum and soils that are more than 40 inches deep to dense glacial till. Also included are small areas of soils that have slopes of less than 15 percent.

Permeability of this Sehome soil is moderate to the dense glacial till and very slow through the till. Available water capacity is moderate to high. Effective rooting depth is 24 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 24 to 36 inches from December to April.

This unit is used mainly as woodland. A few areas are used as pastureland.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 182. On the basis of a 50-year site curve, the mean site index for Douglas fir is 135. The highest average growth rate for Douglas fir is 193 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. Common forest understory plants are salal, Oregongrape, western swordfern, vine maple, trailing blackberry, and salmonberry.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. 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. Logging roads require suitable surfacing for

year-round use. Rock for road construction is not readily available on this unit.

Seedling establishment and the hazard of windthrow are the main concerns 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. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

If this unit is used for pasture, 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. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This map unit is in capability subclass IVe.

122-Sehome gravelly loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is on glaciated hills and low mountainsides. It formed in volcanic ash and loess underlain by glacial till. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 200 to 1,100 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 140 to 180 days.

Typically, the surface is covered with a mat of leaves and twigs 1 inch thick. The surface layer is dark brown gravelly loam 3 inches thick. The subsoil is strong brown and yellowish brown gravelly loam 25 inches thick. Light gray. dense glacial till that crushes to gravelly loam is at a depth of about 28 inches. Depth to dense glacial till ranges from 24 to 40 inches. In some areas the surface layer is loam or silt loam.

Included in this unit are some soils that have a very gravelly sand substratum, soils that are more than 40 inches deep to dense glacial till, and soils that have phyllite fragments in the profile. Also included are small areas of soils that have slopes of less than 30 percent.

Permeability of this Sehome soil is moderate to the dense glacial till and very slow through the till. Available water capacity is moderate to high. Effective rooting depth is 24 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 24 to 36 inches from December to April.

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 for Douglas fir is 182. On the basis of a 50-year site curve, the mean site index for Douglas fir is 135. The highest average growth rate for Douglas fir is 193 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. Common forest understory plants are salal, Oregongrape, western swordfern, vine maple, trailing blackberry, and salmon berry.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion.

Seedling establishment and the hazard of windthrow are the main concerns 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. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIe.

123-Skagit silt loam. This very deep, poorly drained soil is on flood plains and deltas. Drainage has been altered by use of tile and open ditches. This soil is partially protected from flooding. It formed in recent alluvium and volcanic ash. Slope is 0 to 1 percent. The vegetation in areas not cultivated is mainly hardwoods and conifers. Elevation is 0 to 50 feet. The average annual precipitation is about 32 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 12 inches thick. The upper 8 inches of the underlying material is gray silt loam, the next 6 inches is gray silty clay loam, the next 24 inches is gray silt loam, and the lower part to a depth of 60 inches or more is dark gray very fine sandy

Figure 4.-Broccoli in an area of Skagit silt loam.

loam. In some areas the surface layer is silty clay loam.

Included in this unit are some soils that are very strongly acid or are salt-affected in the underlying material and soils that are sandy or have strata of muck or peat in the underlying material. Also included are small areas of Field and Tacoma soils, drained soils on flood plains, Mt. Vernon soils on flood plains and natural levees, and Skagit soils that are subject to ponding in winter.

Permeability of this Skagit soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 6 to 24 inches from November to March. Runoff is slow, and the hazard of water erosion is slight. During the growing season, the water table is lowered to a depth of about 36 to 60 inches. Flooding is rare in areas protected by dikes; however, this soil is subject to frequent, long periods of flooding in areas not protected by dikes and in areas that receive runoff from adjacent uplands.

Most areas of this unit are used as cropland (fig. 4). A few areas are used as hayland, pastureland, and homesites.

This unit is well suited to use as cropland if dikes and drainage systems are adequate and well maintained. Special design of drainage systems and adequate pumping to control the water table are needed in some areas. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, fertility, and tilth. Subsoiling and keeping tillage to a minimum help to prevent development of a plowpan. Puddling and compaction of the soil can be reduced by returning crop residue to the soil and by using minimum tillage.

Common forage plants on this unit are perennial grasses. legumes, oats, and corn. Applying animal manure on grass-legume crops periodically during the growing season helps to maintain organic matter content, fertility, and tilth. Heavy applications of manure tend to smother crops unless it is harrowed to break up the crust. Use of proper stocking rates, pasture rotation,

and restricted grazing during wet periods helps to keep the pasture in good condition.

If this unit is used for homesite development, the main limitations are wetness and the hazard of flooding. Deep drainage helps to overcome the problem of wetness. Adequate construction and proper maintenance of dikes reduces the hazard of flooding. Septic tank absorption fields do not function properly because of wetness. Effluent from the absorption fields may contaminate ground water. Community sewage systems are needed.

This unit has potential for use as woodland. On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 85. The potential highest average growth rate for red alder is 92 cubic feet per acre per year at age 40. Trees of limited extent include black cottonwood, western redcedar, and bigleaf maple. Common forest understory plants include willow, hardhack. and rush.

This map unit is in capability subclass IIw,

124-Skipopa silt loam, 0 to 3 percent slopes. This very deep., somewhat poorly drained soil is on terraces. It formed in a mantle of loess and volcanic ash underlain by glaciolacustrine sediment. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 150 to 450 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 51 degrees F. and the average frost-free season is 160 to 200 days.

Typically, the surface is covered with a mat of leaves and twigs 1 inch thick. The surface layer, where mixed to a depth of 8 inches, is dark brown silt loam. The subsoil is dark yellowish brown silt loam 8 inches thick. The substratum to a depth of 60 inches or more is gray, olive, and bluish gray silty clay. In some areas the surface layer is gravelly silt loam, and in some areas the substratum has lenses of sandy material.

Included in this unit are small areas of Bellingham soils in depressional areas, Gilligan and Indianola soils on outwash terraces, and Tokul soils on hills.

Permeability of this Skipopa soil is very slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 12 to 24 inches from October to June. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as hayland and pastureland. If adequately drained, the unit is also suited to climatically adapted cultivated crops. It is also used as woodland and homesites.

The main limitation for hay and pasture is the perched water table. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

Douglas fir and red alder are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 147 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 114 for Douglas fir and 97 for red alder. The highest average growth rate for Douglas fir is 154 cubic feet per acre per year at age 60; the highest average growth rate for red alder is 113 cubic feet per acre per year at age 40. Among the trees of limited extent are western redcedar. western hemlock, and bigleaf maple. Common forest understory plants are western swordfern, bedstraw, salmonberry, Pacific trillium, and red huckleberry.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. The perched water table limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas fir or western redcedar 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 can prevent the establishment of seedlings. Because the rooting depth is restricted by the perched water table, trees frequently are subject to windthrow.

This unit is limited for homesite development mainly by the perched water table and very slow permeability. Tile drainage can be used to lower the water table if suitable outlets are available. Septic tank absorption fields do not function properly because of wetness and very slow permeability. Effluent from the absorption fields may contaminate ground water. Community sewage systems are needed.

This map unit is in capability subclass IIIw.

125-Skipopa silt loam, 3 to 8 percent slopes. This very deep, somewhat poorly drained soil is on terraces. It formed in a mantle of loess and volcanic ash

underlain by glaciolacustrine sediment. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 150 to 450 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 200 days.

Typically. the surface is covered with a mat of leaves and twigs 1 inch thick. The surface layer, where mixed to a depth of 8 inches, is dark brown silt loam. The subsoil is dark yellowish brown silt loam 8 inches thick. The substratum to a depth of 60 inches or more is gray, olive, and bluish gray silty clay. In some areas the surface layer is gravelly silt loam. In some areas the substratum has lenses of sandy material.

Included in this unit are small areas of Bellingham soils in depressional areas, Gilligan and Indianola soils on outwash terraces, and Tokul soils on hills.

Permeability of this Skipopa soil is very slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at a depth of 12 to 24 inches from October to June. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used as hayland. pastureland, and homesites. If adequately drained. the unit is suited to climatically adapted cultivated crops.

Douglas fir and red alder are the main woodland species on this unit. On the basis of a 100-year site curve. the mean site index is 147 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 114 for Douglas fir and 97 for red alder. The highest average growth rate for Douglas fir is 154 cubic feet per acre per year at age 60; the highest average growth rate for red alder is 113 cubic feet per acre per year at age 40. Among the trees of limited extent are western redcedar, western hemlock, and bigleaf maple. Common forest understory plants are western swordfern, bedstraw, salmonberry, Pacific trillium, and red huckleberry.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil,, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. The perched water table limits the use of equipment to dry periods. Disturbance of the protective layer of duff can be reduced with the careful use of wheeled and tracked equipment.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas fir or western redcedar 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 can prevent the establishment of seedlings. Because the rooting depth is restricted by the perched water table, trees frequently are subject to windthrow.

The main limitation for hay and pasture is the perched water table. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Seedbed preparation should be on the contour or across the slope where practical.

This unit is limited for homesite development mainly by the perched water table and very slow permeability. Tile drainage can be used to lower the water table if suitable outlets are available. Septic tank absorption fields do not function properly because of wetness and very slow permeability. Effluent from the absorption fields may contaminate the ground water. Community sewage systems are needed.

This map unit is in capability subclass IIIw.

126-Skiyou gravelly silt loam, 3 to 15 percent slopes. This very deep, well drained soil is on glacially modified hills. It formed in loess, volcanic ash. and glacial till. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 150 to 1,100 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of leaves and twigs 1.5 inches thick. The surface layer, where mixed to a depth of 7 inches, is brown gravelly silt loam. The upper 7 inches of the subsoil is reddish brown gravelly silt loam, and the lower 9 inches is dark brown gravelly loam. The substratum to a depth of 60 inches or more is dark yellowish brown and light olive brown very gravelly fine sandy loam. In some areas the surface layer is gravelly loam.

Included in this unit are some soils that have a loamy sand or very gravelly sand substratum or are underlain by dense glacial till. Also included are small areas of Wickersham soils on alluvial fans.

Permeability of this Skiyou soil is moderate. Available

water capacity is moderately high to 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 as hayland, pastureland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 179. On the basis of a 50-year site curve, the mean site index for Douglas fir is 133. The highest average growth rate for Douglas fir is 190 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Common forest understory plants are blackberry, salmonberry, western swordfern, western brackenfern, and stinging nettle.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Rounded pebbles for road surfacing are available. 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 in the production of timber. Reforestation can be accomplished by planting Douglas fir or western hemlock 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 can prevent the establishment of Douglas fir seedlings.

The main limitation for hay and pasture is the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Seedbed preparation should be on the contour or across the slope where practical.

This unit is limited for homesite development mainly by steepness of slope. Steepness of slope is a concern in installing septic tank absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IIIe.

127-Skiyou gravelly silt loam, 15 to 30 percent slopes. This very deep, well drained soil is on glacially modified hills. It formed in loess, volcanic ash, and glacial till. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 150 to 1,100 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of leaves and twigs 1 inch thick. The surface layer, where mixed to a depth of 7 inches, is very dark brown gravelly silt loam. The upper 7 inches of the subsoil is reddish brown gravelly silt loam, and the lower 9 inches is dark brown gravelly loam. The substratum to a depth of 60 inches or more is dark yellowish brown and light olive brown very gravelly fine sandy loam.

Included in this unit are some soils that have a very gravelly loamy sand substratum or are underlain by dense glacial till.

Permeability of this Skiyou soil is moderate. Available water capacity is moderately high to 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. A few areas are used as pastureland.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 179. On the basis of a 50-year site curve, the mean site index for Douglas fir is 133. The highest average growth rate for Douglas fir is 190 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, and red alder. Common forest understory plants are blackberry, western swordfern, salmonberry, western brackenfern, and stinging nettle.

The main limitation for the harvesting of timber is muddiness caused by soil wetness. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Rounded pebbles for road surfacing are available. Establishing plant cover on steep cuts and fills 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 in the production of timber. Reforestation can be accomplished by planting Douglas fir or western hemlock 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 can prevent the establishment of Douglas fir seedlings.

In areas used for pasture, 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. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This map unit is in capability subclass lVe.

128-Skykomish very gravelly sandy loam, 30 to 65 percent slopes. This very deep, somewhat excessively drained soil is on terrace escarpments and hills. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers. Elevation is 1,000 to 1,600 feet. The average annual precipitation is about 75 inches. the average annual air temperature is about 44 degrees F, and the average frost-free season is 100 to 125 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer. where mixed to a depth of 7 inches, is dark brown very gravelly sandy loam. The subsoil is brown very gravelly sandy loam 10 inches thick. The substratum to a depth of 60 inches or more is yellowish brown very gravelly loamy sand. In some areas the surface layer is gravelly loam or very cobbly sandy loam.

Included in this unit are small areas of Saxon soils on lacustrine terraces, Jug soils on terraces, and soils that have dense glacial till at a depth of 20 to 40 inches and are on glaciated hills.

Permeability of this Skykomish soil is moderately rapid in the subsoil and very rapid in the substratum. Available water capacity is low to moderately high. 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 and Douglas fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 149 for western hemlock and 136 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 106 for western hemlock and 107 for Douglas fir. The highest average growth rate is 236 cubic feet per acre per year for western hemlock at age 50 and 139 cubic feet per acre per year for Douglas fir at age 70. Among the trees of limited extent are western redcedar and red alder. Common forest understory plants are red huckleberry, western swordfern, western brackenfern, salmonberry, deer fern, vine maple, and salal.

The main limitation for the harvesting of timber is steepness of slope. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are readily available on this unit. Establishing plant cover on steep cuts and fills reduces erosion. Occasional snowpack limits the use of equipment and restricts access.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas fir or western hemlock 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 rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass Vle.

129-Skykomish very gravelly loam, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on terraces. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers. Elevation is 1,000 to 1,600 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 100 to 125 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer, where mixed to a depth of 7 inches, is dark reddish brown and strong brown very gravelly loam. The upper part of the subsoil is strong brown very gravelly sandy loam 12 inches thick, and the lower part is strong brown very gravelly loamy sand 9 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely gravelly loamy sand. Depth to sand and gravel ranges from 15 to 25 inches.

Included in this unit are some soils that have dense glacial till or argillite at a depth of 20 to 40 inches and soils that are less than 15 inches deep to a coarse-textured substratum. Also included in this unit are small areas of Saxon soils on lacustrine terraces and Jug soils on terraces.

Permeability of this Skykomish soil is moderately rapid in the upper part of the subsoil and is very rapid in the lower part of the subsoil and in the substratum. Available water capacity is low to moderately 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. Some areas are used as homesites.

Western hemlock and Douglas fir are the main woodland species on this unit. On the basis of a 100-

year site curve, the mean site index is 149 for western hemlock and 136 for Douglas fir. On the basis of a 50year site curve, the mean site index is 106 for western hemlock and 107 for Douglas fir. The highest average growth rate is 236 cubic feet per acre per year for western hemlock at age 50 and 139 cubic feet per acre per year for Douglas fir at age 70. Among the trees of limited extent are western redcedar and red alder. Common forest understory plants are red huckleberry, western swordfern, western brackenfern, salmonberry, and deer fern.

The main limitations for the harvesting of timber are soil wetness during the rainy season and occasional snowpack. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are readily available on this unit. Occasional snowpack limits the use of equipment and restricts access.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas fir or western hemlock 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 rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This unit is suited to homesite development. The very rapid permeability of the soil limits the proper operation of septic tank absorption fields. 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 IVe.

130-Snohomish silt loam. This very deep, poorly drained soil is in back swamps of flood plains. Drainage has been altered by use of tile and open ditches. This soil is partially protected from flooding. It formed in alluvium underlain by peat or muck. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly water-tolerant conifers and deciduous trees. Elevation is 5 to 30 feet. The average annual precipitation is about 30 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 170 to 220 days.

Typically, the surface layer is very dark grayish brown silt loam 13 inches thick. The upper 17 inches of the underlying material is gray and dark gray silt loam, and the lower part to a depth of 60 inches or more is dark grayish brown, strong brown, very dark grayish brown, and black sapric and hemic material. In some areas the surface layer is silty clay loam. Depth to the organic material is 17 to 36 inches.

Included in this unit are soils that are silt loam or sandy material to a depth of 50 inches and are organic material below this depth. Also included are small areas of soils that have an extremely acid substratum.

Permeability of this Snohomish soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 12 to 48 inches from November to May. Runoff is slow, and the hazard of water erosion is slight. Flooding is rare in areas protected by dikes; however, this soil is subject to frequent, long periods of flooding in areas not protected by dikes.

This unit is used as cropland, hayland, and pastureland.

This unit is well suited to use as cropland. If it is used for row crops, the main limitation is the seasonal high water table. Most crops common to the area can be grown if the drainage system is adequate; tile systems and field ditches can be used. Returning all crop residue to the soil and using cover crops help to maintain organic matter content, 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. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This unit is well 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.

This unit has potential for use as woodland. On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 80. The potential highest average growth rate for red alder is 84 cubic feet per acre per year at age 40. The trees of limited extent include western redcedar, Sitka spruce, and western hemlock. Common forest understory plants include sedges, vine maple, devilsclub, bedstraw, skunkcabbage, salmonberry, and red huckleberry.

This map unit is in capability subclass IIw.

131-Snoqualmie fine sandy loam. This very deep, somewhat excessively drained soil is on river terraces. It formed in alluvium. Slope is 0 to 3 percent. The native vegetation is mainly hardwoods and conifers. Elevation is 40 to 100 feet. The average annual precipitation is

about 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 140 to 200 days.

Typically, the surface layer is very dark grayish brown fine sandy loam 8 inches thick. The upper 9 inches of the underlying material is grayish brown loamy sand,, and the lower part to a depth of 60 inches or more is gray very gravelly sand. Depth to very gravelly sand ranges from 6 to 20 inches. In some areas the surface layer is cobbly silt loam or cobbly fine sandy loam.

Included in this unit are small areas of Snoqualmie soils that have slopes of more than 3 percent, soils along drainageways that are wet, Pilchuck soils on flood plains, soils that are loamy to a depth of 16 to 30 inches. and Riverwash.

Permeability of this Snoqualmie soil is very rapid below a depth of about 17 inches. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. A seasonal high water table fluctuates between depths of 36 and 60 inches from November to April, when the water level of the river is high. This soil is subject to frequent, brief periods of flooding from November to April.

This unit is used as woodland and wildlife habitat.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 143. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 110. The highest average growth rate for Douglas fir is 149 cubic feet per acre per year at age 65. Among the trees of limited extent are red alder. western hemlock, western redcedar, and black cottonwood. Common forest understory plants are western swordfern, Oregongrape, vine maple, deer fern, thimbleberry. trailing blackberry, and salmonberry.

The main limitation for the harvesting of timber is flooding in winter. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil. and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available on this unit. The surface layer is loose when dry, which limits the use of wheeled and tracked equipment. Flooding limits the use of equipment to dry periods.

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 red alder occurs readily. The droughtiness of the surface layer reduces the survival rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIw.

132-Sorensen very gravelly silt loam, 3 to 30 percent slopes. This very deep, well drained soil is on glacially modified mountainsides. It formed in volcanic ash and glacial till influenced by phyllite. The native vegetation is mainly conifers. Elevation is 1,000 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 150 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 11 inches thick. The surface layer, where mixed to a depth of 6 inches, is dark brown very gravelly silt loam. The upper 3 inches of the subsoil is dark yellowish brown very gravelly silt loam, and the lower 9 inches is light olive brown extremely gravelly loam. The substratum to a depth of 60 inches or more is olive and pale olive extremely gravelly loam. In some areas the surface layer is gravelly silt loam. In some areas the substratum is clay loam.

Included in this unit are small areas of Montborne and Rinker soils and Rock outcrop on mountainsides.

Permeability of this Sorensen soil is moderate. Available water capacity is moderately high to high. 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.

Western hemlock and Douglas fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 134 for western hemlock and 154 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 105 for western hemlock and 118 for Douglas fir. The highest average growth rate is 207 cubic feet per acre per year for western hemlock at age 50 and 163 cubic feet per acre per year for Douglas fir at age 60. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Common forest understory plants are red huckleberry, western swordfern, and western brackenfern.

The main limitations for the harvesting of timber are muddiness caused by seasonal soil wetness and occasional snowpack. 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 slippery when wet. Logging roads require suitable surfacing for year-round use.

Rock for road construction is not readily available on this unit. Cutbanks may slump when the soil is saturated. Occasional snowpack limits the use of equipment and restricts access. Establishing plant cover on steep cuts and fills reduces erosion.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass IVe.

133-Sorensen very gravelly silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on glacially modified mountainsides. It formed in volcanic ash and glacial till influenced by phyllite. The native vegetation is mainly conifers. Elevation is 1,000 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is about 120 to 150 days.

Typically, the surface is covered with a mat of needles, twigs, and wood fragments 11 inches thick. The surface layer, where mixed to a depth of 6 inches, is dark brown very gravelly silt loam. The upper 3 inches of the subsoil is dark yellowish brown very gravelly silt loam, and the lower 9 inches is light olive brown extremely gravelly loam. The substratum to a depth of 60 inches or more is olive and pale olive extremely gravelly loam. In some areas the surface layer is gravelly silt loam, the substratum is clay loam, or dense glacial till or phyllite is at a depth of 20 to 40 inches.

Included in this unit are small areas of Montborne and Rinker soils and Rock outcrop on mountainsides. Permeability of this Sorensen soil is moderate. Available water capacity is moderately high to high. 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 and Douglas fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 134 for western hemlock and 154 for Douglas fir. On the basis of a 50-year site curve, the mean site index is 105 for western hemlock and 118 for Douglas fir. The highest average growth rate is 207 cubic feet per acre per year for western hemlock at age 50 and 163 cubic feet per acre per year for Douglas fir at age 60. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Common forest understory plants are red huckleberry, western swordfern, and western brackenfern.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are slippery when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Following road construction and clearcutting, road failures and landslides are likely to occur.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings.

This map unit is in capability subclass VIe.

134-Springsteen very gravelly loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on glacially modified mountains. It formed in volcanic ash, glacial till, and colluvium derived from phyllite. The native vegetation is mainly conifers. Elevation is 2,000 to 3,100 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 90 to 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 5 inches thick. The surface layer, where mixed to a depth of 6 inches, is brown very gravelly loam. The subsoil is strong brown and light olive brown very gravelly loam 17 inches thick. The substratum is light yellowish brown extremely channery loam about 12 inches thick. Fractured phyllite is at a depth of about 35 inches. Depth to phyllite ranges from 20 to 40 inches. In some areas dense glacial till is at a depth of 20 to 40 inches.

Included in this unit are small areas of soils that are less than 20 inches deep to phyllite and small areas of Rock outcrop on mountainsides.

Permeability of this Springsteen soil is moderate. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. 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 for western hemlock is 137. On the basis of a 50-year site curve, the mean site index for western hemlock is 96. The highest average growth rate for western hemlock is 213 cubic feet per acre per year at age 50. Among the trees of limited extent are Pacific silver fir. Douglas fir, and western redcedar. Common forest understory plants are salmonberry, tall blue huckleberry, bunchberry dogwood, queencup beadlily, and deer fern.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Occasional snowpack hinders the use of equipment and limits access in winter. Establishing plant cover on steep cuts and fills reduces erosion.

Seedling mortality and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock, Douglas fir, or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The mortality rate of seedlings is higher in areas on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. Because the rooting depth is restricted by the underlying bedrock, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIe.

135-Squires very gravelly silt loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on glacially modified mountains. It formed in colluvium derived from phyllite, volcanic ash, and glacial till. The native vegetation is mainly conifers. Elevation is 400 to 1,500 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 160 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer, where mixed to a depth of 6 inches is brown very gravelly silt loam. The subsoil is strong brown very gravelly silt loam 11 inches thick. The substratum is light olive brown and grayish brown very gravelly loam about 15 inches thick. Fractured phyllite is at a depth of about 32 inches. Depth to phyllite ranges from 20 to 40 inches.

Included in this unit are small areas of Blethen and Vanzandt soils, soils that are less than 20 inches deep to bedrock, and Rock outcrop on mountainsides.

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

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 for Douglas fir is 176. On the basis of a 50-year site curve, the mean site index for Douglas fir is 132. The highest average growth rate for Douglas fir is 186 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. Common forest understory plants are western swordfern, western brackenfern, red huckleberry, ladyfern, and broadleaf starflower.

The main limitation for the harvesting of timber is steepness of slope. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. 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 cuts and fills reduces erosion.

Seedling establishment and the hazard of windthrow are the main concerns 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 droughtiness of the surface layer reduces the survival rate of seedlings. The mortality rate of seedlings is higher in areas on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Because the rooting depth is restricted by the underlying bedrock, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIe.

136-Sumas silt loam. This very deep, poorly drained soil is on flood plains and deltas. Drainage has been altered by tiling. This soil is partially protected from flooding. It formed in alluvium. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly hardwoods and conifers. Elevation is 0 to 50 feet. The average annual precipitation is about 32 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the upper 6 inches of the surface layer is very dark grayish brown silt loam and the lower 7 inches is very dark grayish brown silty clay loam. The upper 3 inches of the underlying material is gray silt loam, the next 14 inches is gray loamy sand, and the lower part to a depth of 60 inches or more is dark gray coarse sand. In some areas the surface layer is silty clay loam.

Included in this unit are small areas of Field, Mt. Vernon, and Skagit soils on flood plains. In some tidal areas are soils that are similar to this Sumas soil but have strongly acid to very strongly acid underlying material. Also included are areas of Sumas soils that are subject to ponding in winter.

Permeability of this Sumas soil is moderate in the upper part and rapid in the lower part. Available water capacity is moderately high. Areas affected by tides are moderately saline. Effective rooting depth is limited by a seasonal high water table that is at a depth of 12 to 36 inches from November to April. Runoff is very slow, and the hazard of water erosion is none. Flooding is rare in areas protected by dikes; however, this soil is subject to frequent. long periods of flooding in areas not protected by dikes.

This unit is used as cropland, hayland, and pastureland.

This unit is well suited to use as cropland if dikes and drainage systems are maintained. If the unit is used for row crops, the main limitation is the seasonal high water table. Open ditches and tile lines can be used to lower the water table and leach excess salts. Soil amendments aid the leaching process. Returning all crop residue to the soil and using cover crops are essential to maintain organic matter content, fertility, and tilth. Subsoiling and minimum tillage help to prevent development of a plowpan. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

Common forage plants on this unit are perennial grasses, legumes, oats, and corn. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

This unit has potential for use as woodland. On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 80. The potential highest average growth rate for red alder is 84 cubic feet per acre per year at age 40. The trees of limited extent include western redcedar. Common forest understory plants include western brackenfern, western swordfern, devilsclub, and creambush oceanspray.

This map unit is in capability subclass IIw.

137-Swinomish gravelly loam, 0 to 8 percent slopes. This moderately deep., moderately well drained soil is on ridges of hills, It formed in glacial till with an admixture of loess and volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 1,200 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown gravelly loam 3 inches thick. The upper 17 inches of the subsoil is strong brown gravelly loam, and the lower 4 inches is yellowish brown very gravelly fine sandy loam. The upper 5 inches of the substratum is light olive brown very gravelly fine sandy loam, and the lower 2 inches is light olive brown very gravelly sandy loam. Dense glacial till that crushes to very gravelly sandy loam is at a depth of about 31 inches. Depth to dense glacial till ranges from 25 to 40 inches. In some areas the soil does not have properties associated with weathered volcanic ash, and in some areas it is moderately deep to bedrock.

Included in this unit are small areas of Catla soils on hills, Bow and Laconner soils on glaciated remnant terraces, and Coveland soils in swales.

Permeability of this Swinomish soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 25 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A perched water table fluctuates between depths of 24 and 36 inches from November to May.

This unit is used mainly as woodland. It is also used as hayland, pastureland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 125. On the basis of a 50-year site curve, the mean site index for Douglas fir is 95. The highest average growth rate for Douglas fir is 122 cubic

feet per acre per year at age 70. Among the trees of limited extent are grand fir, western redcedar, and western hemlock. Common forest understory plants are western swordfern, trailing blackberry, twinflower, vine maple. currant, rose, and Indian plum.

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

Seedling establishment and the hazard of windthrow are the main concerns 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 grand fir occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

The main limitation for hay and pasture is droughtiness in summer and early in fall. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

If this unit is used for homesite development, the main limitations are the depth to dense glacial till and the perched water table. Wetness can be reduced by installing drain tile around footings. Excavation for building sites is limited by the dense glacial till. The main limitations for septic tank absorption fields are the depth to dense glacial till and the perched water table. Use of interceptor drains, additional topsoil placed over the absorption field, and longer than normal absorption lines helps to compensate for these limitations.

This map unit is in capability subclass IIIe.

138-Swinomish gravelly loam, 8 to 15 percent slopes. This moderately deep, moderately well drained soil is on ridges of hills. It formed in glacial till with an admixture of loess and volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 1,200 feet. The average annual precipitation is about 23 inches. the average annual air temperature is about 50 degrees F. and the average frost-free season is 160 to 210 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown gravelly loam 3 inches thick. The upper 17 inches of the subsoil is strong brown gravelly loam, and the lower 4 inches is yellowish brown very gravelly fine sandy loam. The upper 5 inches of the substratum is light olive brown very gravelly fine sandy loam, and the lower 2 inches is light olive brown very gravelly sandy loam. Dense glacial till that crushes to very gravelly sandy loam is at a depth of about 31 inches. Depth to dense glacial till ranges from 25 to 40 inches. In some areas the soil does not have properties associated with weathered volcanic ash, and in some areas it is moderately deep to bedrock.

Included in this unit are small areas of Catla soils on hills, Bow and Laconner soils on glaciated remnant terraces, and Coveland soils in swales.

Permeability of this Swinomish soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 25 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A perched water table fluctuates between depths of 24 and 36 inches from November to May.

This unit is used mainly as woodland. It is also used as hayland, pastureland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 125. On the basis of a 50-year site curve, the mean site index for Douglas fir is 95. The highest average growth rate for Douglas fir is 122 cubic feet per acre per year at age 70. Among the trees of limited extent are grand fir, western redcedar, and western hemlock. Common forest understory plants are western swordfern, trailing blackberry, twinflower. vine maple, currant, rose, and Indian plum.

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

Seedling establishment and the hazard of windthrow are the main concerns 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 grand fir occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of

seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

The main limitations of this unit for hay and pasture are droughtiness of the soil in summer and early in fall and the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Seedbed preparation should be on the contour or across the slope where practical.

If this unit is used for homesite development, the main limitations are depth to the dense glacial till, steepness of slope, and the perched water table. Wetness can be reduced by installing drain tile around footings. Excavation for building sites is limited by the dense glacial till. The main limitations for septic tank absorption fields are depth to the dense glacial till, the perched water table, and steepness of slope. Use of interceptor drains, additional topsoil placed over the absorption field, and longer than normal absorption lines placed on the contour helps to compensate for these limitations.

This map unit is in capability subclass IIIe.

139-Swinomish gravelly loam, 15 to 30 percent slopes. This moderately deep, moderately well drained soil is on the sides of hills. It formed in glacial till with an admixture of loess and volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 1,000 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F. and the average frost-free season is 160 to 210 days.

Typically, the surface is covered with a mat of needles. leaves, and twigs 1 inch thick. The surface layer is dark brown gravelly loam 3 inches thick. The upper 17 inches of the subsoil is strong brown gravelly loam, and the lower 4 inches is yellowish brown very gravelly fine sandy loam. The upper 5 inches of the substratum is light olive brown very gravelly fine sandy loam, and the lower 2 inches is light olive brown very gravelly sandy loam. Dense glacial till that crushes to very gravelly sandy loam is at a depth of about 31 inches. Depth to dense glacial till ranges from 25 to 40 inches. In some areas the soil does not have properties associated with weathered volcanic ash, and in some small areas it is moderately deep to bedrock.

Included in this unit are small areas of Catla soils on hills. Bow and Laconner soils on glaciated remnant terraces, and Swinomish soils that have slopes of less than 15 percent.

Permeability of this Swinomish soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 25 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A perched water table fluctuates between depths of 24 and 36 inches from November to May.

This unit is used mainly as woodland. It is also used as pastureland and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 125. On the basis of a 50-year site curve, the mean site index for Douglas fir is 95. The highest average growth rate for Douglas fir is 122 cubic feet per acre per year at age 70. Among the trees of limited extent are grand fir, western redcedar, and western hemlock. Common forest understory plants are western swordfern, trailing blackberry, twinflower, vine maple, currant, rose, and Indian plum.

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

Seedling establishment and the hazard of windthrow are the main concerns 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 grand fir occurs periodically. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

The main limitations of this unit for pasture are the hazard of erosion and droughtiness of the soil in summer and early in fall. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

If this unit is used for homesite development, the main limitations are steepness of slope, depth to the dense glacial till, and the perched water table. Excavation for roads and building sites increases the hazard of erosion. Only the part of the site that is used

for construction should be disturbed. The hazard of erosion is increased if the soil is left exposed during site development. Structures to divert runoff are needed if buildings and roads are constructed.

Septic tank absorption fields do not function properly because of steepness of slope, the very slow permeability of the dense glacial till, and the perched water table. Effluent from septic tank absorption fields can surface in downslope areas and thus create a hazard to health. Community sewage systems are needed.

This map unit is in capability subclass IVe.

140-Swinomish-Fidalgo-Rock outcrop complex, 3 to 30 percent slopes. This map unit is on foot slopes of mountainsides and ridges of hills. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 1,000 feet. The average annual precipitation is about 20 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

This unit is about 40 percent Swinomish gravelly loam. about 35 percent Fidalgo gravelly 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 Coveland soils in swales and Bow and Laconner soils on remnant terraces.

The Swinomish soil is moderately deep and moderately well drained. It formed in glacial till with an admixture of volcanic ash. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is dark brown gravelly loam 3 inches thick. The upper 17 inches of the subsoil is strong brown gravelly loam, and the lower 4 inches is yellowish brown very gravelly fine sandy loam. The upper 5 inches of the substratum is light olive brown very gravelly fine sandy loam, and the lower 2 inches is light olive brown very gravelly sandy loam. Dense glacial till that crushes to very gravelly sandy loam is at a depth of about 31 inches. Depth to dense glacial till ranges from 25 to 40 inches. In some areas the surface layer is very gravelly loam, and in some areas dense glacial till is at a depth of more than 40 inches.

Permeability of the Swinomish soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 25 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. A perched water table fluctuates between depths of 24 and 36 inches from November to May.

The Fidalgo soil is moderately deep and moderately well drained. It formed in colluvium. glacial till, and residuum derived dominantly from argillite. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is very dark brown gravelly loam 3 inches thick. The upper 15 inches of the subsoil is dark brown very gravelly fine sandy loam, and the lower 7 inches is dark brown very gravelly sandy loam. The substratum is very dark brown extremely gravelly loamy sand 4 inches thick over hard argillite. Depth to argillite ranges from 20 to 40 inches.

Permeability of the Fidalgo soil is moderate. Available water capacity is low to 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 fluctuates between depths of 24 and 36 inches from December to March.

Rock outcrop consists of exposures of hard and mostly unweathered argillite. It occurs as steep cliffs and irregular formations.

This unit is used as woodland.

Douglas fir is the main woodland species on the Swinomish soil. On the basis of a 100-year site curve, the mean site index for Douglas fir is 125. On the basis of a 50-year site curve, the mean site index for Douglas fir is 95. The highest average growth rate for Douglas fir is 122 cubic feet per acre per year at age 70. Among the trees of limited extent are grand fir, western redcedar, and western hemlock. Common forest understory plants are western swordfern, trailing blackberry, twinflower, vine maple, currant, and rose.

Douglas fir is the main woodland species on the Fidalgo soil. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 100. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 75. The highest average growth rate for Douglas fir is 84 cubic feet per acre per year at age 60. Among the trees of limited extent are western redcedar, lodgepole pine, western hemlock, and grand fir. Common forest understory plants are Pacific madrone, Oregongrape, trailing blackberry, rose, broadleaf starflower, creambush oceanspray, currant, and Indian plum.

The areas of Rock outcrop make up about 15 percent of this unit and limit yields accordingly.

The main limitations for the harvesting of timber are the areas of Rock outcrop and muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round

use. Rock for road construction is readily available on this unit. Rock outcrop hinders harvesting operations. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Avoiding large areas of Rock outcrop forces yarding paths to converge, which results in compaction of the soil.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas fir seedlings. The areas of Rock outcrop limit the even distribution of reforestation. If seed trees are present, natural reforestation of cutover areas by grand fir occurs periodically. The droughtiness of the surface layer of the Fidalgo soil reduces the survival rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIe.

141-Tacoma silt loam. This very deep, very poorly drained soil is on deltas. It formed in alluvium and volcanic ash and thin layers of organic material. Slope is 0 to 2 percent. The vegetation is mainly saltgrasses, sedges, and rush. Elevation is 1 foot to 10 feet. The average annual precipitation is about 25 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface layer is gray silt loam 10 inches thick. The upper 40 inches of the underlying material is gray silt loam that is very strongly acid or extremely acid and has strata of decomposed plant material, and the lower part to a depth of 60 inches or more is gray, stratified silt loam and silty clay loam. In some areas the underlying material has strata of sand.

Permeability of this Tacoma soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at or above the surface during periods of high tide. Runoff is ponded, and the hazard of water erosion is none. This soil is subject to frequent, brief periods of tidal flooding year round. The soil is moderately saline.

This unit is used as wildlife habitat and recreation.

This map unit is in capability subclass Vw.

142-Tacoma silt loam, drained. This very deep, very poorly drained soil is on deltas. Drainage has been altered by use of tile and open ditches. This soil is partially protected from flooding. It formed in alluvium and volcanic ash and thin lenses of organic material. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly saltgrasses, sedges, and rush. Elevation is 1 foot below sea level to 10 feet above sea level. The average annual precipitation is about 25 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 200 days.

Typically, the surface layer is dark grayish brown silt loam 9 inches thick. The upper 24 inches of the underlying material is gray and light brownish gray silt loam, and the next 17 inches is gray silty clay loam. These layers of underlying material are strongly acid or extremely acid and have strata of decomposed plant material. The lower part of the underlying material to a depth of 60 inches or more is gray silt loam. It is extremely acid. In some areas the lower part of the underlying material is sandy, and in some areas the profile does not have properties associated with weathered volcanic ash.

Included in this unit are small areas of Field soils on flood plains and Skagit and Sumas soils on deltas and flood plains.

Permeability of this Tacoma soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 12 to 36 inches from November to April. Runoff is slow, and the hazard of water erosion is slight. Flooding is rare in areas protected by dikes; however, this soil is subject to frequent, long periods of flooding in areas not protected by dikes. This soil is moderately saline.

This unit is used as cropland, hayland, and pastureland.

This unit is well suited to use as cropland. The main limitations are the seasonal high water table and the content of salts that are toxic to plants. Field ditches, tile lines, and pumping stations are used to remove excess water, to provide an outlet for excess salts, and to lower the water table. Sprinkler irrigation can be used to leach out excess salts. Salt amendments aid the leaching process. Care needs to be taken to maintain tile lines at the proper depth to control the level of acidity. Most crops common to the area can be grown if the drainage system is adequate. Special design of the drainage system is needed in some areas used for intensive farming. Sump pumps are needed where gravity flow cannot be attained. Returning all crop residue to the soil and using cover crops are essential to maintain organic matter content, fertility, and tilth. Subsoiling and minimum tillage help to prevent the development of a plowpan.

Common forage plants on this unit are perennial grasses, legumes, oats, and corn. Applying animal

manure and returning crop residue to the soil help to maintain organic matter content, fertility, and tilth. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

This map unit is in capability subclass IIIw.

143-Terric Medisaprists, 0 to 2 percent slopes. These deep, poorly drained soils are in back swamps of flood plains and in depressional areas on till plains. The soils formed in decomposed organic matter over mineral material. The vegetation is mainly shrubs and water-tolerant conifers. Elevation is 10 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 150 to 190 days.

No single profile is representative of these soils, but one commonly observed in the survey area has a surface layer of black muck about 17 inches thick. The underlying material to a depth of 60 inches or more is greenish gray silty clay. Depth to mineral material ranges from 16 to 50 inches. In some areas the surface layer is mucky silt loam, and in some areas the underlying material is silty clay loam or sandy loam.

Included in this unit are small areas of soils that have been partially drained and Mukilteo muck.

Permeability of these Terric Medisaprists is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at or above the surface from November to May. Runoff is ponded, and the hazard of water erosion is none.

Most areas of this unit are used for wildlife habitat. A few areas are used as hayland and pastureland.

The main limitations of this unit for hay and pasture are ponding and soil wetness. Excessive water on the surface can be removed by open drains. Tile drains and open drains can be used to lower the water table 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.

This map unit is in capability subclass Vw.

144-Thornton silt loam. This very deep, somewhat poorly drained soil is on terraces. It formed in glaciolacustrine sediment derived from talc. Slope is 0 to 3 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 150 to 250 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 180 to 220 days.

Typically, the surface is covered with a mat of needles. leaves, and twigs 2 inches thick. The surface layer, where mixed to a depth of 7 inches, is grayish brown silt loam. The underlying material to a depth of 60 inches or more is white and light gray silt loam. In some areas the surface layer is silty clay loam, in some areas the underlying material has strata of sand, and in some areas gravel is in the profile.

Included in this unit are small areas of Wickersham soils on alluvial fans and Gilligan soils on outwash terraces.

Permeability of this Thornton soil is slow. Available water capacity is high. Effective rooting depth is limited by a perched water table that is at the surface to a depth of 12 inches below the surface from December to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as pastureland and hayland. It is also used as woodland and homesites.

The main limitation for pasture and hay is the perched water table. Tile drains and open drains can be used to lower the water table if a suitable outlet is available. Drainage tile should be closely spaced because of the slow permeability. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

Western hemlock is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 125. On the basis of a 50-year site curve, the mean site index for western hemlock is estimated to be 90. The highest average growth rate for western hemlock is 190 cubic feet per acre per year at age 50. Among the trees of limited extent are Douglas fir, western redcedar, red alder, Sitka spruce. and paper birch. Common forest understory plants are western swordfern, ladyfern, false lilyofthevalley, and vine maple.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are slippery when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. The perched water table limits the use of equipment to dry periods.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas fir, western hemlock, or western redcedar seedlings. If seed trees are present. natural reforestation of cutover areas by red alder occurs readily and by western hemlock it occurs periodically. The perched water table

reduces root respiration, which results in a low survival rate of seedlings. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted seedlings. Because the rooting depth is restricted by the perched water table, trees occasionally are subject to windthrow.

The main limitations of this unit for use as homesites are soil wetness and slow permeability. Tile drainage can be used to lower the water table if suitable outlets are available. Septic tank absorption fields do not work properly because of the slow permeability and soil wetness. Effluent from absorption fields may contaminate the ground water. Community sewage systems are needed.

This map unit is in capability subclass IVw.

145-Tisch silty clay loam. This very deep, very poorly drained soil is in narrow stream drainageways. It formed in alluvium, diatomaceous earth, and volcanic ash. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly hardwoods, shrubs, and water-tolerant conifers. Elevation is 50 to 250 feet. The average annual precipitation is about 35 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 olive gray silty clay loam 11 inches thick. The upper 27 inches of the underlying material is light gray silt loam, and the lower part to a depth of 60 inches or more is gray and very dark grayish brown, stratified silt loam and hemic material. In some areas the surface layer is muck or silt loam.

Included in this unit are small areas of Bellingham soils in depressional areas and Sumas soils on flood plains.

Permeability of this Tisch soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at or above the surface from December to June. Runoff is ponded during the rainy season, and the hazard of water erosion is slight.

This unit is used as pastureland and wildlife habitat.

If this unit is used for pasture, the main limitations are ponding and the seasonal high water table. Excessive water on the surface can be removed by use of tiles and open ditches. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition.

This unit has potential for use as woodland. On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 70. The potential highest average growth rate for red alder is 66 cubic feet per acre per year at age 40. The trees of limited extent include western redcedar. Common forest understory plants include sedges, willow, black hawthorn, and hardhack.

This map unit is in capability subclass Vw.

146-Tokul gravelly loam, 0 to 8 percent slopes. This moderately deep, moderately well drained soil is on glacially modified hills. It formed in volcanic ash and loess underlain by glacial till. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 200 to 1,100 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 150 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is very dark grayish brown gravelly loam 2 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loam 32 inches thick. The substratum is light olive brown gravelly fine sandy loam about 5 inches thick. Olive brown, silica-cemented glacial till that crushes to very gravelly sandy loam is at a depth of about 39 inches. Depth to silica-cemented till ranges from 20 to 40 inches. In some areas the surface layer is loam or silt loam, and in some areas the glacial till is not silica-cemented.

Included in this unit are small areas of Elwell, Heisler, Rinker, and Vanzandt soils on low mountainsides and Barneston soils on terraces.

Permeability of this Tokul soil is moderate above the silica-cemented glacial till and very slow through the till. Available water capacity is low to high. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the silica-cemented till at a depth of 18 to 36 inches after periods of heavy rainfall in November to May.

Most areas of this unit are used as woodland. A few areas are used as hayland, pastureland, and homesites.

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 172 for Douglas fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 130 for Douglas fir and 116 for western hemlock. The highest average growth rate is 183 cubic feet per acre per year for Douglas fir at age 60 and 266 cubic feet per acre per year for western hemlock at age 50. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Common forest understory plants are western swordfern, western brackenfern, red huckleberry, salal, trailing blackberry, salmonberry, vine

maple, deer fern, ladyfern, Oregongrape, and Pacific trillium.

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

Seedling establishment and the hazard of windthrow are the main concerns 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 by western hemlock it occurs periodically. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted seedlings. Because the rooting depth is restricted by the silica-cemented glacial till layer, trees occasionally are subject to windthrow.

This unit is well 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. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

The main limitations of this unit for use as homesites are soil wetness and the very slow permeability of the silica-cemented glacial till. If the unit is used for septic tank absorption fields, use of interceptor drains, additional topsoil placed over the absorption field, and longer than normal absorption lines helps to compensate for these limitations.

This map unit is in capability subclass IIIe.

147-Tokul gravelly loam, 8 to 15 percent slopes. This moderately deep, moderately well drained soil is on glacially modified hills. It formed in volcanic ash and loess underlain by glacial till. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 200 to 1,100 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 150 to 200 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer, where mixed to a depth of 4 inches, is brown gravelly loam. The subsoil is dark brown and dark yellowish brown gravelly loam 24 inches thick. The substratum is light olive brown gravelly fine sandy loam about 5 inches thick. Olive brown, silica-cemented glacial till that crushes to very gravelly sandy loam is at a depth of about 33 inches. Depth to silica-cemented till ranges from 20 to 40 inches. In some areas the surface layer is silt loam or loam.

Included in this unit are small areas of Elwell, Heisler, Rinker, and Vanzandt soils on low mountains. Also included are some soils that have an extremely gravelly sand or very gravelly sandy loam substratum that is not cemented.

Permeability of this Tokul soil is moderate above the silica-cemented glacial till and very slow through the till. Available water capacity is low to high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the silica-cemented till at a depth of 18 to 36 inches after periods of heavy rainfall in November to May.

Most areas of this unit are used as woodland. A few areas are used as hayland, pastureland, and homesites.

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 172 for Douglas fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 130 for Douglas fir and 116 for western hemlock. The highest average growth rate is 183 cubic feet per acre per year for Douglas fir at age 60 and 266 cubic feet per acre per year for western hemlock at age 50. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Common forest understory plants are western swordfern, western brackenfern, red huckleberry, salal, trailing blackberry, salmonberry, vine maple, deer fern, ladyfern, Oregongrape, and Pacific trillium.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. The perched water table limits the use of equipment to dry periods. Cutbanks may slump when the soil is saturated.

Seedling establishment and the hazard of windthrow are the main concerns 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 by western hemlock it occurs periodically. When openings are made in the canopy, invading

brushy plants can prevent the establishment of planted seedlings. Because the rooting depth is restricted by the silica-cemented till layer, trees occasionally are subject to windthrow.

The main limitation of this unit for hay and pasture is the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Seedbed preparation should be on the contour or across the slope where practical.

The main limitations of this unit for use as homesites are soil wetness and steepness of slope. The main limitations for septic tank absorption fields are soil wetness, the very slow permeability of the silica-cemented till layer, and steepness of slope. Use of interceptor drains, additional topsoil placed over the absorption field, and longer than normal absorption lines placed on the contour helps to compensate for these limitations.

This map unit is in capability subclass IIIe.

148-Tokul gravelly loam, 15 to 30 percent slopes. This moderately deep, moderately well drained soil is on glacially modified hills. It formed in volcanic ash and loess underlain by glacial till. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 200 to 1,100 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F. and the average frost-free season is 150 to 200 days.

Typically, the surface is covered with a mat of needles. leaves, and twigs 3 inches thick. The surface layer is dark grayish brown gravelly loam 2 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loam 24 inches thick. The substratum is light olive brown gravelly fine sandy loam about 5 inches thick. Olive brown, silica-cemented glacial till that crushes to very gravelly sandy loam is at a depth of about 31 inches. Depth to silica-cemented till ranges from 20 to 40 inches.

Included in this unit are small areas of Cathcart, Elwell, Heisler, and Vanzandt soils on low mountains and small areas of soils that are more than 40 inches deep and are on hills.

Permeability of this Tokul soil is moderate above the silica-cemented glacial till and very slow through the till. Available water capacity is low to high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the silica-cemented till at a depth of 18 to 36 inches from November to May.

Most areas of this unit are used as woodland. A few areas are used as homesites.

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 172 for Douglas fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 130 for Douglas fir and 116 for western hemlock. The highest average growth rate is 183 cubic feet per acre per year for Douglas fir at age 60 and 266 cubic feet per acre per year for western hemlock at age 50. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Common forest understory plants are western swordfern, western brackenfern, red huckleberry, salal, trailing blackberry, salmonberry, vine maple, deer fern, ladyfern, Oregongrape, and Pacific trillium.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. The perched water table limits the use of equipment to dry periods. Cutbanks may slump when the soil is saturated.

Seedling establishment and the hazard of windthrow are the main concerns 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 by western hemlock it occurs periodically. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted seedlings. Because the rooting depth is restricted by the silica-cemented till layer, trees occasionally are subject to windthrow.

The main limitations of this unit for use as homesites are steepness of slope, depth to the silica-cemented glacial till, and the perched water table. Excavation for roads and building sites increases the hazard of erosion. Only the part of the site that is used for construction should be disturbed. The hazard of erosion is increased if the soil is left exposed during site development. Structures to divert runoff are needed if buildings and roads are constructed. Septic tank absorption fields do not function properly because of steepness of slope, the very slow permeability of the silica-cemented glacial till, and the perched water table.

Effluent from septic tank absorption fields can surface in downslope areas and thus create a hazard to health. Community sewage systems are needed.

This map unit is in capability subclass lVe.

149-Tokul gravelly loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is on glacially modified hills. It formed in loess and volcanic ash underlain by glacial till. The native vegetation is mainly mixed conifers and hardwoods. Elevation is 200 to 1,100 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 150 to 200 days.

Typically, the surface is covered with a mat of needles. leaves, and twigs 2 inches thick. The surface layer is dark brown gravelly loam 2 inches thick. The subsoil is dark brown and dark yellowish brown gravelly loam 23 inches thick. The substratum is light olive brown gravelly fine sandy loam about 5 inches thick. Olive brown, silica-cemented glacial till that crushes to very gravelly sandy loam is at a depth of about 30 inches. Depth to silica-cemented glacial till ranges from 20 to 40 inches. In some areas the surface layer is loam or silt loam.

Included in this unit are small areas of Sorensen and Vanzandt soils on low mountains and soils that are more than 40 inches deep and are on hills. Also included are small areas of Barneston and Winston soils on terraces and some soils that have a loam subsoil and a sand substratum.

Permeability of this Tokul soil is moderate above the silica-cemented glacial till and very slow through the till. Available water capacity is low to high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the silica-cemented till at a depth of 18 to 36 inches from November to May.

This unit is used 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 172 for Douglas fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 130 for Douglas fir and 116 for western hemlock. The highest average growth rate is 183 cubic feet per acre per year for Douglas fir at age 60 and 266 cubic feet per acre per year for western hemlock at age 50. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. Common forest understory plants are western swordfern, western brackenfern, red huckleberry, salal, trailing blackberry, salmonberry, vine maple, deer fern, ladyfern, Oregongrape, and Pacific trillium.

The main limitation for the harvesting of timber is steepness of slope. Steepness of slope restricts the use of wheeled and tracked equipment in skidding operations; cable yarding systems are safer and disturb the soil less. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. The perched water table limits the use of equipment to dry periods. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Following road construction and clearcutting, road failures and landslides are likely to occur.

Seedling establishment and the hazard of windthrow are the main concerns 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 by western hemlock it occurs periodically. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Because the rooting depth is restricted by the silica-cemented till layer, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIe.

150-Typic Cryorthods-Rock outcrop complex, 65 to 90 percent slopes. This map unit is on dissected glacially modified mountainsides. The native vegetation is mainly conifers and shrubs. Elevation is 2,800 to 4,000 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 38 degrees F, and the average frost-free season is 80 to 120 days.

This unit is about 70 percent Typic Cryorthods and about 20 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 Crinker soils and small areas of soils that are less than 20 inches deep and are on mountainsides.

The Typic Cryorthods are moderately deep to very deep and are moderately well drained. They formed in volcanic ash and colluvium derived dominantly from phyllite. No single profile is representative of these soils,, but one commonly observed in the survey area is covered with a mat of needles, leaves, and twigs about

2 inches thick. The surface layer, where mixed to a depth of 7 inches, is brown very gravelly silt loam. The subsoil is dark reddish brown and yellowish brown very gravelly silt loam and very gravelly loam 14 inches thick. The substratum to a depth of 60 inches or more is grayish brown and light olive brown very channery loam. Depth to dense glacial till or phyllite ranges from 20 inches to more than 60 inches.

Permeability of these Typic Cryorthods is moderate. Available water capacity is low to high. Effective rooting depth is 20 inches to more than 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of hard and mostly unweathered phyllite, argillite, and other medisedimentary rock. It occurs as steep cliffs and irregular formations.

This unit is used as woodland.

Western hemlock and Pacific silver fir are the main woodland species on the Typic Cryorthods in this unit. On the basis of a 100-year site curve, the mean site index for western hemlock is 111. On the basis of a 50-year site curve, the mean site index for western hemlock is 78. The highest average growth rate for western hemlock is 162 cubic feet per acre per year at age 50. Estimates of the site index and yield for Pacific silver fir have not been made. The areas of Rock outcrop make up about 20 percent of this unit and limit yields accordingly. Among the trees of limited extent is mountain hemlock. Common forest understory plants are bunchberry dogwood, blueleaved huckleberry, and queencup beadlily.

The main limitation for the harvesting of timber is steepness of slope. Cable yarding systems generally are used on this unit. Rock for road construction is readily available on this unit. Winter snowpack hinders the use of equipment and limits access. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by Pacific silver fir and western hemlock occurs periodically. The areas of Rock outcrop limit the even distribution of reforestation.

This map unit is in capability subclass VIIe.

151-Typic Cryorthods-Rock outcrop, granite complex, 65 to 90 percent slopes. This map unit is on glacially modified mountainsides. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 4,200 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 38 degrees F, and the average frost-free season is 75 to 115 days.

This unit is about 70 percent Typic Cryorthods and about 30 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 soils that are shallow to granite.

The Typic Cryorthods are moderately deep to very deep and are moderately well drained. They formed in volcanic ash and colluvium derived dominantly from granite. No single profile is representative of these soils, but one commonly observed in the survey area is covered with a mat of needles, leaves, and twigs about 2 inches thick. The surface layer, where mixed to a depth of 7 inches, is brown very gravelly sandy loam. The upper 30 inches of the subsoil is yellowish brown and light yellowish brown very gravelly sandy loam, and the lower part to a depth of 60 inches or more is brownish yellow very gravelly loamy sand.

Permeability of these Typic Cryorthods is moderately rapid. Available water capacity is low to moderately high. Effective rooting depth is 20 inches to more than 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

Rock outcrop consists of exposures of hard and mostly unweathered granite. It occurs as steep cliffs and irregular formations.

This unit is used as woodland.

Western hemlock and Pacific silver fir are the main woodland species on the Typic Cryorthods in this unit. On the basis of a 100-year site curve, the mean site index for western hemlock is 85. On the basis of a 50-year site curve, the mean site index for western hemlock is 60. The highest average growth rate for western hemlock is 97 cubic feet per acre per year at age 60. Estimates of the site index and yield for Pacific silver fir have not been made. The areas of Rock outcrop make up about 30 percent of this unit and limit yields accordingly. Among the trees of limited extent is mountain hemlock. Common forest understory plants are bunchberry dogwood, blueleaved huckleberry, and queencup beadlily.

The main limitation for the harvesting of timber is steepness of slope. Cable yarding systems generally are used on this unit. Rock for road construction is readily available on this unit. Winter snowpack hinders the use of equipment and limits access. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Harvesting systems that lift logs entirely

off the ground reduce the disturbance of the protective layer of duff.

Seedling mortality and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present. natural reforestation of cutover areas by Pacific silver fir and western hemlock occurs periodically. The droughtiness of the surface layer reduces the survival rate of seedlings. The areas of Rock outcrop limit the even distribution of reforestation. Because the rooting depth is restricted by granite in some areas, trees occasionally are subject to windthrow.

This map unit is in capability subclass VIIe.

152-Urban land-Mt. Vernon-Field complex. This map unit is on flood plains and natural levees. Slope is 0 to 3 percent. The native vegetation is mainly conifers and shrubs. Elevation is 10 to 50 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 220 days.

This unit is about 40 percent Urban land, 30 percent Mt. Vernon very fine sandy loam, and 20 percent Field 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 some small areas of soils that are underlain by a layer of sand 10 inches thick or more and soils that are silty throughout. Also included are small areas of Mt. Vernon soils that have slopes of more than 3 percent and soils that are poorly drained.

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

The Mt. Vernon soil is very deep and moderately well drained. It formed in recent alluvium with an admixture of volcanic ash. Typically, the surface layer is dark brown very fine sandy loam 10 inches thick. The upper 19 inches of the underlying material is dark yellowish brown and grayish brown, stratified very fine sandy loam, fine sandy loam, loamy fine sand, and fine sand, and the lower part to a depth of 60 inches or more is grayish brown and olive gray, stratified silt loam, very fine sandy loam, fine sandy loam, loamy fine sand, and fine sand. In some areas the surface layer is sandy loam or silt loam, and in some areas the surface layer is not dark colored.

Permeability of this Mt. Vernon soil is moderate. 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 April. Runoff is slow, and the hazard of water erosion is slight. The water table has been lowered by drainage of adjacent lowland areas. This soil is subject to occasional, brief periods of flooding from November to April.

The Field soil is very deep and moderately well drained. It formed in recent alluvium with an admixture of volcanic ash. Typically, the surface layer is dark brown silt loam 13 inches thick. The upper 8 inches of the underlying material is olive silt loam, the next 19 inches is grayish brown and dark gray, stratified fine sand and loamy fine sand, and the lower part to a depth of 60 inches or more is gray and dark gray, stratified very fine sandy loam and fine sand. In some areas the surface layer is fine sandy loam, in some areas the underlying material is loamy, and in some areas the surface layer is thick.

Permeability of this Field soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 60 inches from November to May. The water table has been lowered by drainage of adjacent lowland areas. Runoff is slow, and the hazard of water erosion is slight. Flooding is rare in areas protected by dikes; however, this soil is subject to frequent, brief periods of flooding in November to March in areas not protected by dikes.

The Mt. Vernon and Field soils in this unit are used for lawns, gardens, parks, and vacant lots.

If this unit is used for homesite development, the main limitations are the hazard of flooding and the seasonal high water table. The hazard of flooding can be reduced by careful maintenance of dikes. Tile drains and open ditches can be used to lower the water table if suitable outlets are available. Septic tank absorption fields do not function properly because of wetness. Effluent from the absorption fields may contaminate ground water. Community sewage systems are needed. Roads and streets should be located above the expected flood level.

This map unit is in capability subclass IIw.

153-Vanzandt very gravelly loam, 0 to 15 percent slopes. This moderately deep, moderately well drained soil is on glacially modified plains. It formed in volcanic ash and glacial till. The native vegetation is mainly conifers. Elevation is 250 to 1,500 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 140 to 180 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer, where mixed to a depth of 6 inches, is dark

brown very gravelly loam. The subsoil is dark brown and yellowish brown very gravelly loam 19 inches thick. The substratum is olive gray very gravelly sandy loam about 11 inches thick. Olive gray, dense glacial till that crushes to very gravelly sandy loam is at a depth of about 36 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam or gravelly loam, and in some areas the till is silica-cemented.

Included in this unit are small areas of Wickersham soils on alluvial fans, Tokul soils on hills, soils that are more than 40 inches deep and are on till plains, and Barneston soils on terraces.

Permeability of this Vanzandt soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the dense glacial till at a depth of 18 to 36 inches after rainy periods from December to April.

This unit is used mainly as woodland. It is also used as hayland, pastureland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 159. On the basis of a 50-year site curve, the mean site index for Douglas fir is 125. The highest average growth rate for Douglas fir is 169 cubic feet per acre per year at age 65. Among the trees of limited extent are western hemlock, western redcedar, red alder, and bigleaf maple. Common forest understory plants are Oregongrape, western swordfern, western brackenfern, and vine maple.

The main limitation for the harvesting of timber is wetness during winter. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion.

Seedling establishment and the hazard of windthrow are the main concerns 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 periodically. Seedlings planted in the less fertile subsoil exhibit poor growth and vigor. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

The main limitation of this unit for hay and pasture is droughtiness of the soil. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water. Seedbed preparation should be on the contour or across the slope where practical.

The main limitations of this unit for use as homesites are soil wetness during winter, steepness of slope, and the very slow permeability of the dense glacial till. Tile drainage can be used to lower the water table if suitable outlets are available. Septic tank absorption fields do not function properly because of wetness and the very slow permeability. Effluent from the absorption fields may contaminate the ground water. Community sewage systems are needed.

This map unit is in capability subclass IVe.

154-Vanzandt very gravelly loam, 15 to 30 percent slopes. This moderately deep, moderately well drained soil is on glacially modified plains. It formed in volcanic ash and glacial till. The native vegetation is mainly conifers. Elevation is 250 to 1,500 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 140 to 180 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer, where mixed to a depth of 6 inches, is dark brown very gravelly loam. The subsoil is dark brown and yellowish brown very gravelly loam 19 inches thick. The substratum is olive gray very gravelly sandy loam about 12 inches thick. Olive gray, dense glacial till that crushes to very gravelly sandy loam is at a depth of about 37 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam or gravelly loam.

Included in this unit are small areas of Squires soils on low mountains, Barneston soils on terraces, Tokul soils on hills, and soils that are more than 40 inches deep and are on till plains.

Permeability of this Vanzandt soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 18 to 36 inches from December to April.

This unit is used mainly as woodland. It is also used as hayland, pastureland, and homesites.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is 159. On the basis of a 50-year site curve, the mean site index for Douglas fir is 125. The highest average growth rate for Douglas fir is 169 cubic feet per acre per year at age 65. Among the trees of limited extent are western hemlock, western redcedar, red alder, and bigleaf maple. Common forest understory plants are Oregongrape, western swordfern, western brackenfern, and vine maple.

The main limitation for the harvesting of timber is wetness during winter. Material cast to the side ravels and commonly sloughs when saturated. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion.

Seedling establishment and the hazard of windthrow are the main concerns 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 periodically. Seedlings planted in the less fertile subsoil exhibit poor growth and vigor. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

The main limitations of this unit for hay and pasture are the hazard of erosion and droughtiness of the soil. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition and to protect the soil from erosion. Seedbed preparation should be on the contour or across the slope were practical. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

The main limitations of this unit for use as homesites are steepness of slope, soil wetness during winter, and the very slow permeability of the dense glacial till. Tile drainage can be used to lower the water table if suitable outlets are available. Septic tank absorption fields do not function properly because of wetness, very slow permeability, and steepness of slope. Effluent from septic tank absorption fields can surface in downslope areas and thus create a hazard to health. Also, effluent from the absorption fields may contaminate ground water. Community sewage systems are needed. Access roads should be designed to control surface runoff and to help stabilize cut slopes. This map unit is in capability subclass IVe.

155-Vanzandt very gravelly loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is on glacially modified, low mountainsides. It formed in volcanic ash and glacial till. The native vegetation is mainly conifers. Elevation is 250 to 1,500 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 140 to 180 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 9 inches thick. The surface layer, where mixed to a depth of 6 inches, is dark brown very gravelly loam. The subsoil is dark brown and yellowish brown very gravelly loam 18 inches thick. The substratum is olive brown very gravelly loam about 12 inches thick. Olive gray, dense glacial till that crushes to very gravelly loam is at a depth of about 36 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the surface layer is gravelly loam.

Included in this unit are small areas of Squires soils and Rock outcrop on low mountains, Tokul soils on hills, and soils that are more than 40 inches deep and are on till plains.

Permeability of this Vanzandt soil is moderate above the dense glacial till and very slow through the till. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 18 to 36 inches from December to April.

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 for Douglas fir is 175. On the basis of a 50-year site curve, the mean site index for Douglas fir is 134. The highest average growth rate for Douglas fir is 186 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, red alder, and bigleaf maple. Common forest understory plants are Oregongrape, western swordfern, western brackenfern, and vine maple.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. 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. Logging roads

require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Cutbanks may slump when the soil is saturated. Establishing plant cover on steep cuts and fills reduces erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are protected by plant cover or adequate water bars are provided.

Seedling establishment and the hazard of windthrow are the main concerns 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 periodically. Seedlings planted in the less fertile subsoil exhibit poor growth and vigor. When openings are made in the canopy, invading brushy plants can prevent the establishment of seedlings. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass Vle.

156-Whistle-Fidalgo-Rock outcrop complex, 30 to 65 percent slopes. This map unit is on mountainsides. The native vegetation is mainly conifers and shrubs. Elevation is 20 to 1,300 feet. The average annual precipitation is about 20 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

This unit is about 50 percent Whistle very gravelly loam, 20 percent Fidalgo gravelly loam, and 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 Swinomish soils on ridges, Coveland soils in swales, and Bow soils on glaciated remnant terraces.

The Whistle soil is deep and well drained. It formed in colluvium derived dominantly from glacial till, volcanic ash,, loess, and argillite or phyllite. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is very dark brown very gravelly loam 3 inches thick. The upper 9 inches of the subsoil is brown very gravelly sandy loam, and the lower 14 inches of the subsoil is brown extremely gravelly sandy loam. The upper 10 inches of the substratum is dark grayish brown very gravelly sandy loam, and the lower 13 inches is olive brown extremely gravelly sandy loam. Argillite is at a depth of about 49 inches. Depth to argillite ranges from 40 to 60 inches.

Permeability of the Whistle soil is moderate. Available water capacity is moderate to high. Effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Fidalgo soil is moderately deep and moderately well drained. It formed in colluvium, glacial till, and residuum derived dominantly from argillite. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is very dark brown gravelly loam 3 inches thick. The upper 15 inches of the subsoil is dark brown very gravelly fine sandy loam, and the lower 7 inches is dark brown very gravelly sandy loam. The substratum is very dark brown extremely gravelly loamy sand 4 inches thick. Argillite is at **a** depth of 29 inches. Depth to argillite ranges from 20 to 40 inches.

Permeability of the Fidalgo soil is moderate. Available water capacity is low to moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. A perched water table fluctuates between depths of 24 and 36 inches from December to March.

Rock outcrop consists of exposures of hard and mostly unweathered argillite. It occurs assteep cliffs and irregular formations.

This unit is used as woodland and watershed.

Douglas fir is the main woodland species on the Whistle soil. On the basis of a 100-year site curve, the mean site index for Douglas fir is 85. On the basis of a 50-year site curve, the mean site index for Douglas fir is 75. The highest average growth rate for Douglas fir is 64 cubic feet per acre per year at age 70. Among the trees of limited extent are western redcedar and western hemlock. Common forest understory plants are Oregongrape, trailing blackberry, hollygrape, rose, and currant.

Douglas fir is the main woodland species on the Fidalgo soil. On the basis of a 100-year site curve, the mean site index for Douglas fir is 100. On the basis of a 50-year site curve, the mean site index for Douglas fir is 75. The highest average growth rate for Douglas fir is 84 cubic feet per acre per year at age 60. Among the trees of limited extent are western redcedar, lodgepole pine, western hemlock, and grand fir. Common forest understory plants are Pacific madrone, Oregongrape, trailing blackberry, rose, broadleaf starflower, creambush oceanspray, currant, and Indian plum.

The areas of Rock outcrop make up about 15 percent of this unit and limit yields accordingly.

The main limitation for the harvesting of timber is steepness of slope. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts,

compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails on the Fidalgo soil are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available on this unit. Rock outcrop hinders harvesting operations. Areas of Rock outcrop may cause breakage of timber when felled and hinder yarding. Avoiding large areas of Rock outcrop forces yarding paths to converge, which results in compaction of the soil.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting Douglas fir seedlings. The low available water capacity during the growing season results in a high mortality rate of seedlings. The areas of Rock outcrop limit the even distribution of reforestation. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings. If seed trees are present, natural reforestation by grand fir occurs periodically on the Fidalgo soil. Because the rooting depth is restricted by the underlying bedrock in the Fidalgo soil, trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong.

This map unit is in capability subclass VIIe.

157-Wickersham silt loam, 0 to 8 percent slopes. This very deep, well drained soil is on alluvial fans and terraces. It formed in alluvium derived from phyllite. The native vegetation is mainly conifers and hardwoods. Elevation is 150 to 400 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 150 to 200 days.

Typically, the surface is covered with a mat of leaves and twigs 2 inches thick. The surface layer is dark olive gray silt loam 7 inches thick. The upper 11 inches of the subsoil is olive gray silt loam, and the lower 6 inches is olive gray channery loam. The upper 9 inches of the substratum is olive gray very channery loamy sand, and the lower part to a depth of 60 inches or more is very dark gray extremely channery sand. Depth to the substratum ranges from 15 to 33 inches. In some areas the surface layer is channery loam or channery silt loam. In some areas the profile is very gravelly throughout, and in some areas the substratum is at a depth of 5 to 15 inches.

Included in this unit are small areas of Mukilteo soils in depressional areas, Samish soils on terraces, and Riverwash along streams.

Permeability of this Wickersham soil is moderate in the surface and subsoil and very rapid in the substratum. Available water capacity is moderately high. 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.

This unit is used mainly as hayland and pastureland. It is also used as woodland and homesites. The unit is suited to climatically adapted cultivated crops.

This unit is well 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. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

Douglas fir is the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 171. On the basis of a 50-year site curve, the mean site index for Douglas fir is 130. The highest average growth rate for Douglas fir is 182 cubic feet per acre per year at age 60. Among the trees of limited extent are red alder, paper birch, western redcedar, and western hemlock. Common forest understory plants are red elderberry, salmonberry, and geranium.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Unsurfaced roads are soft and slippery when wet and can 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. Use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Special low ground pressure equipment can reduce damage to the soil.

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 red alder occurs readily. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted seedlings.

The main limitations of this unit for use as homesites are the hazard of flooding and the poor filtering capacity of the soil. Dikes need to be maintained to control flooding. The very rapid permeability of the substratum limits the proper operation of septic tank absorption fields. If density housing is moderate to high, community sewage systems are needed to prevent contamination of ground water as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIIe.

158-Winston gravelly silt loam, 0 to 8 percent slopes. This very deep, well drained soil is on terraces.

It formed in volcanic ash and loess underlain by glacial outwash. The native vegetation is mainly conifers. Elevation is 250 to 1,000 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 140 to 180 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer, where mixed to a depth of 6 inches, is brown gravelly silt loam. The subsoil is strong brown and dark brown gravelly silt loam 18 inches thick. The substratum to a depth of 60 inches or more is light olive brown extremely gravelly sand. Depth to the substratum ranges from 16 to 30 inches. In some areas the surface layer is gravelly loam, in some small areas the surface layer and the upper part of the subsoil are more than 35 percent gravel, and in some areas the substratum is sandy and the profile is nongravelly.

Included in this unit are small areas of Kline soils on alluvial fans and Tokul soils on hills.

Permeability of this Winston soil is moderate to the substratum and very rapid in the substratum. Available water capacity is moderately high to 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 as homesites, hayland, and pastureland. The unit is suited to climatically adapted cultivated crops.

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 164 for Douglas fir and 162 for western hemlock. On the basis of a 50-year site curve, the mean site index is 125 for Douglas fir and 114 for western hemlock. The highest average growth rate is 174 cubic feet per acre per year for Douglas fir at age 60 and 258 cubic feet per acre per year for western hemlock at age 50. Among the trees of limited extent are red alder, bigleaf maple, and western redcedar. Common forest understory plants are salal, Oregongrape, western brackenfern, western swordfern, vine maple, red huckleberry, and trailing blackberry.

The main limitation for the harvesting of timber is muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are 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 red alder occurs readily. When openings are made in the canopy, invading brushy plants can prevent the establishment of planted seedlings.

This unit is well suited to homesite development. The main limitation for septic tank absorption fields is the poor filtering capacity of the soil. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of ground water.

The main limitation of this unit for hay and pasture is droughtiness of the soil. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. In summer supplemental irrigation is required for maximum production. Sprinkler irrigation is the most suitable method of applying water.

This map unit is in capability subclass IIIe.

159-Wiseman channery sandy loam, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on alluvial fans. It formed in alluvium derived from phyllite. 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 51 degrees F, and the average frost-free season is 160 to 220 days.

Typically, the surface layer, where mixed to a depth of 7 inches is very dark grayish brown channery sandy loam. The underlying material to a depth of 60 inches or more is dark olive gray extremely channery sand.

Included in this unit are small areas of Barneston, Gilligan, and Wickersham soils on terraces and Vanzandt soils on glaciated low mountainsides.

Permeability of this Wiseman soil is very 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 soil is subject to rare periods of flooding.

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 for Douglas fir is estimated to be 152. On the basis of a 50-year site curve, the mean site index for Douglas fir is estimated to be 115. The highest average growth rate for Douglas fir is 161 cubic feet per acre per year at age 60. Among the trees of limited extent are western hemlock, western redcedar, red alder, and bigleaf maple. Common forest understory plants are western swordfern, western brackenfern, and red elderberry.

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 red alder occurs readily. Droughtiness of the surface layer reduces the survival rate of seedlings. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings.

This map unit is in capability subclass IVe.

160-Wollard gravelly silt loam, 3 to 30 percent slopes. This moderately deep, moderately well drained soil is on glacially modified mountainsides. It formed in volcanic ash and glacial till derived dominantly from phyllite. The native vegetation is mainly conifers. Elevation is 2,000 to 3,100 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 40 degrees F, and the average frost-free season is 90 to 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer, where mixed to a depth of 3 inches, is dark grayish brown gravelly silt loam. The upper 5 inches of the subsoil is strong brown gravelly silt loam, and the lower 14 inches is light yellowish brown gravelly loam. The substratum is olive gravelly loam about 10 inches thick. Olive gray, dense glacial till that crushes to gravelly loam is at a depth of about 32 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the profile is more than 35 percent rock fragments, in some areas phyllite is not in the dense till layer, and in some areas the subsoil is more developed.

Included in this unit are small areas of Clendenen. Crinker, and Springsteen soils. Also included are small areas of Rock outcrop.

Permeability of this Wollard soil is moderate above the dense glacial till and very slow through the till. Available water capacity is moderate to high. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the dense glacial till at a depth of 24 to 36 inches from November to April.

This unit is used as woodland.

Western hemlock and Pacific silver fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for westernhemlock is 139. On the basis of a 50-year site curve, the mean site index for western hemlock is 98. The highest average growth rate for western hemlock is 216 cubic feet per acre per year at age 60. Estimates of the site index and growth rate for Pacific silver fir have not been made. Among the trees of limited extent is western redcedar. Common forest understory plants are bunchberry dogwood, deer fern, Pacific trillium, salmonberry, tall blue huckleberry, and trailing blackberry.

The main limitations for the harvesting of timber are occasional snowpack and muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Occasional snowpack hinders the use of equipment and limits access.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings.

This map unit is in capability subclass VIe.

161-Wollard gravelly silt loam, 30 to 65 percent slopes. This moderately deep, moderately well drained soil is on glacially modified mountainsides. It formed in volcanic ash and glacial till derived dominantly from phyllite. The native vegetation is mainly conifers. Elevation is 2,000 to 3,100 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 40 degrees F, and the average frost-free season is 90 to 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer, where mixed to a depth of 4 inches, is light brownish gray gravelly silt loam. The upper 7 inches of the subsoil is yellowish brown gravelly silt loam, and the lower 10 inches is light olive brown gravelly loam. The substratum is pale olive gravelly loam about 14 inches thick. Pale olive, dense glacial till that crushes to gravelly loam is at a depth of about 35 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the profile is more than 35 percent rock

fragments, in some areas phyllite is not in the dense till layer, and in some areas the subsoil is more developed.

Included in this unit are areas of Crinker and Springsteen soils. Also included are small areas of Rock outcrop.

Permeability of this Wollard soil is moderate above the dense glacial till and very slow through the till. Available water capacity is moderate to high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 24 to 36 inches from November to April.

This unit is used as woodland.

Western hemlock and Pacific silver fir are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index for western hemlock is 139. On the basis of a 50-year site curve, the mean site index for western hemlock is 98. The highest average growth rate for western hemlock is 216 cubic feet per acre per year at age 60. Estimates of the site index and growth rate for Pacific silver fir have not been made. Among the trees of limited extent is western redcedar. Common forest understory plants are bunchberry dogwood, deer fern, Pacific trillium, salmonberry,. tall blue huckleberry, and trailing blackberry.

The main limitations for the harvesting of timber are steepness of slope and occasional snowpack. Material cast to the side ravels and commonly sloughs when saturated. 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. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Occasional snowpack hinders the use of equipment and limits access.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation can be accomplished by planting western hemlock or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings.

This map unit is in capability subclass Vle.

162-Wollard-Springsteen gravelly silt loams, 20 to 55 percent slopes. This map unit is on glacially modified broad mountaintops. The native vegetation is mainly conifers. Elevation is 2,400 to 3,100 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 40 degrees F, and the average frost-free season is 90 to 120 days.

This unit is about 50 percent Wollard gravelly silt loam and about 30 percent Springsteen 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 Rock outcrop, poorly drained soils in depressional areas, and Clendenen soils. Also included are some soils that are less than 20 inches or more than 40 inches deep to bedrock.

The Wollard soil is moderately deep and moderately well drained. It formed in volcanic ash and glacial till derived dominantly from phyllite. Typically, the surface is covered with a mat of needles and twigs 4 inches thick. The surface layer. where mixed to a depth of 4 inches, is light brownish gray gravelly silt loam. The upper 7 inches of the subsoil is yellowish brown gravelly silt loam, and the lower 10 inches is light olive brown gravelly loam. The substratum is pale olive gravelly loam about 14 inches thick. Pale olive, dense glacial till that crushes to gravelly loam is at a depth of about 35 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the dense till layer does not have phyllite fragments.

Permeability of the Wollard soil is moderate above the dense glacial till and very slow through the till. Available water capacity is moderate to high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 24 to 36 inches from November to April.

The Springsteen soil is moderately deep and well drained. It formed in volcanic ash and colluvium derived dominantly from phyllite. Typically, the surface is covered with a mat of needles and twigs 5 inches thick. The surface layer, where mixed to a depth of 6 inches, is brown gravelly silt loam. The subsoil is strong brown and light olive brown very gravelly loam 17 inches thick. The substratum is light yellowish brown extremely channery loam 12 inches thick. Phyllite is at a depth of 35 inches. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Springsteen soil is moderate. Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. Runoff is

medium. and the hazard of water erosion is moderate. This unit is used as woodland.

Western hemlock and Pacific silver fir are the main woodland species on the Wollard soil. On the basis of a 100-year site curve, the mean site index for western hemlock is 139. On the basis of a 50-year site curve, the mean site index for western hemlock is 98. The highest average growth rate for western hemlock is 216 cubic feet per acre per year at age 60. Estimates of the site index and growth rate for Pacific silver fir have not been made. Among the trees of limited extent is western redcedar. Common forest understory plants are bunchberry dogwood, deer fern, Pacific trillium, salmonberry, tall blue huckleberry, and trailing blackberry.

Western hemlock is the main woodland species on the Springsteen soil. On the basis of a 100-year site curve, the mean site index for western hemlock is 137. On the basis of a 50-year site curve, the mean site index for western hemlock is 96. The highest average growth rate for western hemlock is 213 cubic feet per acre per year at age 50. Among the trees of limited extent are Pacific silver fir, Douglas fir, and western redcedar. Common forest understory plants are salmonberry, bunchberry dogwood, tall blue huckleberry, deer fern, and queencup beadlily.

The main limitation for the harvesting of timber is steepness of slope. Cable yarding systems generally are used on this unit. Unsurfaced roads and skid trails are slippery when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Occasional snowpack limits the use of equipment and restricts access. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are protected by plant cover or adequate water bars are provided.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation on the Wollard soil can be accomplished by planting western hemlock or noble fir seedlings. Reforestation on the Springsteen soil can be accomplished by planting western hemlock, Douglas fir, or noble fir seedlings. Because the rooting depth is restricted by the underlying bedrock or dense till, trees occasionally are subject to windthrow. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings on the Wollard soil. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically.

This map unit is in capability subclass VIe.

163-Wollard-Springsteen complex, 3 to 30 percent slopes. This map unit is on glaciated mountainsides. The native vegetation is mainly conifers. Elevation is 2,000 to 3,100 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 40 degrees F, and the average frost-free season is 90 to 120 days.

This unit is about 70 percent Wollard gravelly silt loam and about 25 percent Springsteen very 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 Clendenen and Crinker soils and Rock outcrop.

The Wollard soil is moderately deep and moderately well drained. It formed in volcanic ash and glacial till derived dominantly from phyllite. Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer, where mixed to a depth of 3 inches is dark grayish brown gravelly silt loam. The upper 5 inches of the subsoil is strong brown gravelly silt loam, and the lower 14 inches is light yellowish brown gravelly loam. The substratum is olive gravelly loam about 10 inches thick. Olive gray, dense glacial till that crushes to gravelly loam is at a depth of about 32 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the profile is more than 35 percent rock fragments, in some areas phyllite is not in the dense glacial till layer, and in some areas the subsoil is more developed.

Permeability of the Wollard soil is moderate above the dense glacial till and very slow through the till. Available water capacity is moderate to high. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the dense glacial till at a depth of 24 to 36 inches from November to April.

The Springsteen soil is moderately deep and well drained. It formed in volcanic ash and colluvium derived dominantly from phyllite. Typically, the surface is covered with a mat of needles and twigs 5 inches thick. The surface layer, where mixed to a depth of 6 inches, is brown very gravelly loam. The subsoil is strong brown and light olive brown very gravelly loam 17 inches thick. The substratum is light yellowish brown extremely channery loam 12 inches thick. Phyllite is at a depth of 35 inches. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Springsteen soil is moderate.

Available water capacity is low to moderately high. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock and Pacific silver fir are the main woodland species on the Wollard soil. On the basis of a 100-year site curve, the mean site index for western hemlock is 139. On the basis of a 50-year site curve, the mean site index for western hemlock is 98. The highest average growth rate for western hemlock is 216 cubic feet per acre per year at age 60. Estimates of the site index and growth rate for Pacific silver fir have not been made. Among the trees of limited extent is western redcedar. Common forest understory plants are bunchberry dogwood, deer fern, Pacific trillium, salmonberry, tall blue huckleberry, and trailing blackberry.

Western hemlock is the main woodland species on the Springsteen soil in this unit. On the basis of a 100-year site curve,, the mean site index for western hemlock is 137. On the basis of a 50-year site curve, the mean site index for western hemlock is 96. The highest average growth rate for western hemlock is 213 cubic feet per acre per year at age 50. Among the trees of limited extent are Pacific silver fir, Douglas fir, and western redcedar. Common forest understory plants are salmonberry, tall blue huckleberry, bunchberry dogwood, queencup beadlily, and deer fern.

The main limitations for the harvesting of timber are occasional snowpack and muddiness caused by seasonal soil wetness. Use of wheeled and tracked equipment when the soil is moist produces ruts, compacts the soil, and damages the roots of trees. Unsurfaced roads and skid trails are soft when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Occasional snowpack hinders the use of equipment and limits access.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation on the Wollard soil can be accomplished by planting western hemlock or noble fir seedlings. Reforestation on the Springsteen soil can be accomplished by planting western hemlock, Douglas fir, or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong. When openings are made in the canopy, invading brushy plants can delay the establishment of planted seedlings on the Wollard soil.

This map unit is in capability subclass Vle.

164-Wollard-Springsteen complex, 30 to 65 percent slopes. This map unit is on glaciated mountains. The native vegetation is mainly conifers. Elevation is 2,000 to 3,100 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 40 degrees F, and the average frost-free season is 90 to 120 days.

This unit is about 70 percent Wollard gravelly silt loam and about 20 percent Springsteen very 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 Clendenen soils, soils that are more than 40 inches deep, and Rock outcrop.

The Wollard soil is moderately deep and moderately well drained. It formed in volcanic ash and glacial till derived dominantly from phyllite. Typically, the surface is covered with a mat of needles and twigs 4 inches thick. The surface layer, where mixed to a depth of 4 inches, is light brownish gray gravelly silt loam. The upper 7 inches of the subsoil is yellowish brown gravelly silt loam, and the lower 10 inches is light olive brown gravelly loam. The substratum is pale olive gravelly loam about 14 inches thick. Pale olive, dense glacial till that crushes to gravelly loam is at a depth of about 35 inches. Depth to dense glacial till ranges from 20 to 40 inches. In some areas the dense till layer does not have phyllite fragments.

Permeability of the Wollard soil is moderate above the dense glacial till and very slow through the till. Available water capacity is moderate to high. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till at a depth of 24 to 36 inches from November to April.

The Springsteen soil is moderately deep and well drained. It formed in volcanic ash and colluvium derived dominantly from phyllite. Typically, the surface is covered with a mat of needles and twigs 5 inches thick. The surface layer, where mixed to a depth of 6 inches, is brown very gravelly loam. The subsoil is strong brown and light olive brown very gravelly loam 17 inches thick. The substratum is light yellowish brown extremely channery loam 12 inches thick. Phyllite is at a depth of 35 inches. Depth to bedrock ranges from 20 to 40 inches. In some areas the subsoil has organic coatings.

Permeability of the Springsteen soil is moderate. Available water capacity is low to moderately high.

The effective rooting depth is about 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock and Pacific silver fir are the main woodland species on the Wollard soil. On the basis of a 100-year site curve, the mean site index for western hemlock is 139. On the basis of a 50-year site curve, the mean site index for western hemlock is 98. The highest average growth rate for western hemlock is 216 cubic feet per acre per year at age 60. Estimates of the site index and growth rate for Pacific silver fir have not been made. Among the trees of limited extent is western redcedar. Common forest understory plants are bunchberry dogwood, deer fern, Pacific trillium, salmonberry, tall blue huckleberry, and trailing blackberry.

Western hemlock is the main woodland species on the Springsteen soil. On the basis of a 100-year site curve, the mean site index for western hemlock is 137. On the basis of a 50-year site curve, the mean site index for western hemlock is 96. The highest average growth rate for western hemlock is 213 cubic feet per acre per year at age 50. Among the trees of limited extent are Pacific silver fir, Douglas fir, and western redcedar. Common forest understory plants are salmonberry, tall blue huckleberry. bunchberry dogwood, queencup beadlily, and deer fern.

The main limitation for the harvesting of timber is steepness of slope. Material cast to the side ravels and commonly sloughs when saturated. 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. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available on this unit. Occasional snowpack hinders the use of equipment and limits access. Cutbanks slump when the soil is saturated. Establishing plant cover on steep cuts and fills 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 they are protected by plant cover or adequate water bars are provided. Harvesting systems that lift logs entirely off the ground reduce the disturbance of the protective layer of duff.

Seedling establishment and the hazard of windthrow are the main concerns in the production of timber. Reforestation on the Wollard soil can be accomplished by planting western hemlock or noble fir seedlings. Reforestation on the Springsteen soil can be accomplished by planting western hemlock, Douglas fir, or noble fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The mortality rate of seedlings is higher on ridgetops that are subject to strong, persistent winds than it is in other areas of this unit. Trees occasionally are subject to windthrow during periods when the soil is excessively wet and the winds are strong. When openings are made in the canopy, invading brushy plants can delay the establishment of seedlings on the Wollard soil.

This map unit is in capability subclass VIe.

165-Xerorthents, 0 to 5 percent slopes. This map unit is on hills and flood plains. Areas are irregular in shape and are 5 to 40 acres in size. The native vegetation has been removed from the soils in this unit. Elevation is 5 to 250 feet. The average annual precipitation is about 30 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 200 days.

This unit consists of areas where the surface layer and subsoil have been highly disturbed, removed, and replaced with other soil material. Texture and depth are highly variable within short distances.

Included in this unit are small areas of Bow soils on glaciated remnant terraces and Xerofluvents on flood plains. Also included are small areas of soils that are covered with sawdust and other wood wastes.

Permeability, available water capacity, effective rooting depth, surface runoff, and the hazard of erosion are highly variable. They are dependent on the amount of disturbance and cutting or filling of the soil. In some areas a seasonal high water table is at a depth of more than 24 inches from November to March.

This unit is used mainly for log landings and unpaved parking areas. It is also used as fill sites and athletic fields.

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 behavioral 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 for hay and pasture is suggested in this section. 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 commonly grown 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.

It is estimated that one-half of the acreage now being farmed in the survey area is pastureland and hayland. Between 30,000 and 40,000 acres is in permanent forage production, and the remaining acreage of pasture and hay is used for crops grown in rotation. Increased acreage is being used for green chop and hay silage.

Over the past 10 years farmers have grown an average of 22,000 acres of green peas. Green peas, which are processed by five major processing plants, contribute the greatest gross dollar return of all vegetables grown in the area.

Two crops that have drastically dropped in acreage are sweet corn and strawberries. Sweet corn production dropped from 6,000 acres in 1977 to 1,000 acres in 1980 because better quality corn was being produced in eastern Washington. Strawberries declined from 1,800 acres in 1955 to 450 in 1980 because of labor problems, economics, and high production in California and Mexico. In response to these and other crop reductions, winter wheat acreage increased to more than 20,000 acres in 1980. New varieties, high yields, good crop rotation, and a few alternative crops have led to the increase.

Cole crops, vegetable seeds, cucumbers, flower bulbs, and small fruit contribute less in gross income, but they are equal in importance because the net return to the grower from these crops is greater; also, they provide diversity of crops.

Soil drainage is the major management need on about 60 percent of the acreage used for crops and

pasture in the survey area. Unless artificially drained, some soils are naturally so wet that their productive capacity is severely limited. Drainage and diking districts play a very important role in providing drainage outlets. The degree of artificial drainage achieved commonly depends upon the quality of the outlet.

Poorly drained soils, such as those of the Briscot, Nookachamps, Skagit, and Sumas series, make up a large part *of* the cropland that requires drainage to achieve optimal production. Organic soils, such as those of the Mukilteo series and the Mukilteo Variant, also need improved drainage to produce crops. Most soils used for crops and pasture have some degree of artificial drainage, but much of the land needs improved drainage to support the more intensively grown crops. On several thousand acres that do not have adequate drainage, soil compaction is a major management problem. Tillage when the soil is wet, crop rotations that produce little organic residue, and excessive tillage are the main causes of soil compaction.

The design of both surface and subsurface drainage systems varies with the kind of *soil.* A combination of surface and subsurface drainage is needed in most areas of the poorly drained soils used for intensive row cropping. Drains have to be more closely spaced in soils with slow permeability than in the more permeable soils; however, cultural practices such as subsoiling, using adequate crop rotations, and growing winter cover crops should be an integral part of maintaining soil permeability. Without these practices, subsurface drainage does not function at optimal levels, often resulting in surface ponding of water and damage to crops in winter.

Drainage of cropland and pastureland is also being affected by urban development on the uplands. Farmlands adjacent to Bayview Hill, Pleasant Ridge, and Bow Hill receive additional runoff water that must be conveyed away from fields to protect the crops.

Flooding and ponding are a constant threat to most of the agricultural land in the survey area. According to the U.S. Army Corps of Engineers, the Skagit River presents the largest threat to life and property of any river basin in the Puget Sound Region. High flood hazard areas such as the Nookachamps. Hamilton, Sterling, and Samish Flats receive some flooding annually. Because of the threat of flooding, these areas commonly are used for forage and grass production.

Soil erosion is a problem on a small percentage of the cropland and pastureland in the survey area. Erosion on cropland is mainly associated with manmade surface ditches plowed in fields to convey surface water in winter. The result is soil erosion and deposition of sediment in the ditches. Surface ditches need not be installed when fields have subsurface drainage and support winter cover crops.

Because few upland soils are used as cropland, soil erosion on upland soils, such as those of the Bow, Cathcart, Sehome, Tokul, and Skiyou series, commonly is associated with logging activities, roads, or urban development. Where the slope is more than 3 percent, erosion can be a hazard.

Loss of the surface layer through erosion is a concern for two reasons. Firstly, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as those of the Bellingham, Bow, and Skipopa series, and on soils that have a layer in or below the subsoil that limits the depth of the root zone. Such layers include duripans, as in the Tokul soils, and dense glacial till layers, as in the Clallam soils. Erosion also reduces productivity on soils that tend to be droughty, such as those of the Keystone series. Secondly, soil erosion on farmland and woodland results in sediment entering streams, which reduces water quality and damages fish and game habitats. Erosion control minimizes the pollution of streams by sediment and improves quality of water for municipal use, for recreation, and for fish and wildlife.

Commonly used erosion control practices are those that provide a protective plant cover, reduce runoff, and increase infiltration. Subsurface drainage, surface drainage, pasture plantings, diversions, and grassed waterways are used to reduce erosion.

Soil fertility is naturally low in most soils on uplands in the survey area. Many of the soils are medium acid or strongly acid. The soils on flood plains, such as those of the Briscot, Field, Skagit, and Mt. Vernon series, range from medium acid to neutral and are naturally higher in content of plant nutrients than most upland soils. The use of ground limestone to reduce acidity on agricultural lands is a common practice in the area. The prime requisite for good crop production is the addition of organic matter and nitrogen, which are best supplied and maintained by growing legumes and rotating crops, plowing under green manure crops, and adding all available barnyard manure. Intensively grown crops such as cauliflower, vegetable seeds, carrots, and strawberries have necessitated use of precise fertilizer and liming practices.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good filth are warmer and more porous. Many of the cropped soils on the flood plains in the survey area

have a silt loam surface layer that is very high in content of fine silt and contains less than 3 percent organic matter. High silt content and low organic matter content, changes in crop rotations, and the use of large farm implements have caused these silty soils to develop a massive plow layer that shatters into clods when plowed rather than into granular or blocky peds. The result is a very cloddy surface that requires excessive tillage to obtain a good seedbed.

Regularly adding crop residue, manure, and other organic material to the soil can improve soil structure, reduce crusting and hard clod formation, and increase infiltration. Proper timing and prudent use of farm implements also improve soil structure and reduce energy consumption.

The large number of dairy animals in certain areas has created a water pollution problem. It is therefore vital that proper animal waste management be practiced and coordinated with pasture and crop production.

Specialty crops grown in the survey area include potatoes, cucumbers, broccoli, celery, spinach seed. cabbage seed, table beet seed, mustard seed, kale seed, turnip seed, blueberries, strawberries, flower bulbs, and nursery plants. These crops are grown mainly on the Field, Larush. Skagit, Sumas, and Tacoma soils.

Crops grown on lighter textured soils, such as those of the Briscot and Mt. Vernon series, include carrots, sweet corn, raspberries, and filberts.

Because of the wide range of climatic and soil conditions in the survey area, a very diverse and unique growing environment exists that is capable of expanding in several directions according to market demand.

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 ensures 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 for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops (16). 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 woodland and for engineering purposes.

In the capability system, soils generally are 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 few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants 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, 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 Lyn Townsend. foresters. Soil Conservation Service.

Woodland is one of the most important economic resources in the survey area. Most of the soils in the area have the potential to produce a wood crop. Presently. 423,000 acres in the survey area is classified as commercial woodland. Four of the largest forest industry owners control about 224,000 acres of the commercial woodland.

The greatest concentration of noncommercial woodland ownerships in the area are at the lower elevations. These woodland areas are also among the most productive ones.

Forests in the survey area extend from the Puget Sound to the crest of the Cascade Range. Most of the area is included in the western hemlock zone (8). This zone is extensively occupied by second-growth Douglas fir and red alder. Other species important in the zone are western hemlock and western redcedar. In unmanaged. naturally established stands, the proportion of western hemlock to Douglas fir increases as elevation increases. Red alder, bigleaf maple, and black cottonwood stands are widespread.. especially in the low, moist areas along major rivers and other streams and on the Skagit River delta.

The eastern and higher elevation parts of the survey area, generally those at an elevation of more than 1,000 feet, are in the Pacific silver fir zone (8). This zone is occupied mainly by a western hemlock-Pacific silver fir mixed forest in the lower lying, cold areas and grade to a Pacific silver fir-western hemlock mixed forest in the higher, very cold areas. Minor forest components of the higher lying areas are mountain hemlock and Alaska cedar. Hardwood species are of little significance in this zone.

The survey area has several unique geologic and soil areas. Soils derived from dunite and serpentine occur in the north-central part of the area and on Cypress Islands. Overstory vegetation is characterized by stunted stands of western hemlock, western redcedar, and Alaska cedar, and the grass species are those common to exposed headlands of islands. Regeneration of areas that have been harvested is difficult. Planting stock should be obtained from seed sources in the area.

Reforestation is the main concern in the production of timber on all of the soils in the survey area. Hand planting of conifer seedlings obtained from local nurseries is common on all ownerships. Occupation of sites by red alder and brush species is a significant problem in naturally regenerated areas at lower elevations.

The main limitations for harvesting wood crops are muddiness, caused by seasonal soil wetness, and steepness of slope. A variety of equipment is used on all ownerships. Use of ground equipment on slopes of more than 30 percent is considered hazardous to the operation: high lead cable systems that lift logs off the ground are safer and damage the soil less.

Much of the wood harvested in the survey area is also processed there. Lumber is produced by a small number of local mills. Other wood products are made by two softwood mills, one hardwood mill, one plywood

mill, one pole buyer, and about 20 shake and shingle producers. Wood for pulp is processed outside of the survey area. Red alder is used as sawlogs for the furniture construction market; alder pulp is transported to adjacent counties for use in those pulp markets.

There is ever increasing demand for homesites in the survey area. Total commercial woodland acreage may decline as pressure to convert to other uses increases: however, loss of acreage may be partially offset by use of intensive management practices, particularly on State and large private holdings. Several timber companies and public agencies presently are demonstrating the advantages of woodland management to owners of small woodlands.

Forest managers are using soil survey information more often as they seek ways to increase the productivity of their forested land. Certain soils respond better to fertilization, and some are more susceptible to landsliding and erosion following road building and harvesting activities. Still others require special effort to harvest and reforest.

In the section "Detailed Soil Map Units." each unit that is suitable for producing wood crops provides information on forest productivity, limitations for harvesting timber, concerns for producing timber, and common forest understory plants. The methods and procedures used by foresters and soil scientists to develop the information for each map unit are contained in the *National Forestry Manual (19)* and the *Forest Land Grading Procedures Handbook (13).*

Table 6 summarizes the forestry information given in these map unit descriptions and can serve as a quick reference for important woodland interpretations. Following is a brief description of each of the columns in the table.

The *ordination symbol* is based on a uniform system for labeling individual soils to determine the potential productivity and the principle soil properties in relation to any hazards or limitations of that soil (19). The first element of the ordination symbol is a number that denotes potential productivity in terms of cubic meters of wood per hectare per year for the indicator tree species. The indicator species is a tree that commonly grows on the particular soil and is the most productive one: for example, a number 1 would mean 1 cubic meter of wood per hectare per year (14.3 cubic feet per acre per year or about 70 board-feet per acre per year) and 10 would mean the soil has potential for producing 10 cubic meters of wood per acre per year (143 cubic feet per acre per year or about 70 board-feet per acre per year). The second element of the symbol, a letter, indicates the major kind of soil characteristic that limits tree growth or management. The letter X indicates restrictions because of stones or rocks; W, excessive water, either seasonally or year around, in or on the soil; C. clayey soils; D, restricted rooting depth; S, sandy soils; F. soils with coarse fragments that are more than 0.1 inch and less than 10 inches in diameter; and R, relief or steepness of slope. The letter *A* indicates that there are few, if any, limitations for use or management as forest land. If a soil has more than one limitation, the letter denoting the most limiting characteristic is used.

Each soil is also rated for a number of factors to be considered in management. Slight, moderate, and severe are used to indicate the degree of major soil limitations or management problems. For each moderate or severe rating, a sentence in the applicable soil map unit explains the soil factors that are the basis for that rating.

Equipment limitation ratings refer to the limits on the use of equipment, year-round or seasonally, as a result of soil characteristics. A rating of *slight* indicates that use of equipment is not normally restricted in kind or time of year because of soil factors; *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, soil wetness, and stoniness or rockiness are the main factors that cause equipment limitations. As slope gradient and length increase, it becomes more difficult to use wheeled equipment, commonly where slopes are 25 to 35 percent. On steeper slopes, tracked equipment must be used, commonly where slopes are 35 to 45 percent. On the steepest slopes even tracked equipment cannot be operated safely and more sophisticated systems must be used. Soil wetness, especially where the soils are fine textured, can severely limit the use of equipment, making harvesting practical only during dry summer months.

Seedling mortality ratings refer to the probability of death of naturally occurring or planted tree seedlings as influenced by kinds of soil or topographic conditions. Plant competition is not considered in the ratings. The ratings apply to healthy, dormant seedlings from good stock that are properly planted or to naturally established seedlings that germinate during a period of sufficient soil moisture, *Slight* indicates that no problem is expected under usual conditions; *moderate* indicates that some problems of mortality can be expected and that extra precautions are advisable: and *severe*

indicates that mortality will be high and that extra precautions are essential for successful reforestation. Soil wetness and droughtiness of the surface layer, especially on south- or southwest-facing slopes or on ridgetops, account for seedling mortality. To offset these, larger than usual planting stock, special site preparation, surface drainage, or reinforcement planting may be needed.

Windthrow hazard ratings consider the soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees are not normally blown down by wind; strong winds may break trees but not uproot them: *moderate,* that an occasional tree may be blown down during periods of excessive wetness combined with moderate or strong winds: and *severe.* that many trees can be expected to be blown down during periods of soil wetness combined with moderate or strong winds. Restricted rooting depth because of a high water table, limited depth to bedrock, an impervious layer, or poor anchoring of roots because of a loose surface layer and subsoil are responsible for windthrow or tree tipover. Moderate and severe ratings indicate the need for more care in thinning the edges of woodland stands. a plan calling for periodic salvage of windthrown trees, and an adequate road and trail system to allow for salvage operations.

Plant competition ratings refer to the likelihood of the invasion or growth of undesirable brushy plants when openings are made in the tree canopy. *A slight* rating indicates that unwanted brushy plants are not likely to delay natural reforestation and that planted seedlings have good prospects for development without undue competition; *moderate* indicates that competition will delay natural or planted reforestation; and *severe* indicates that competition can be expected to prevent natural or planted reforestation. Favorable climate and soil characteristics account for plant competition problems. In many instances, the key to predicting brush competition problems is the quantity and proximity of seed sources or the quantity of unwanted brush rootstock that will resprout after harvest. Moderate and severe ratings indicate the need for careful and thorough postharvest cleanup in preparation for reforestation and the possibility of mechanically or chemically treating brush to retard its growth and allow seedlings to develop.

Common trees are listed in the general order of decreasing occurrence in the map unit. Listed species occur throughout the range of the map unit. The detailed map unit descriptions indicate the common trees that are principal species (occupying at least 10 percent of the map unit) and minor species (occupying less than 10 percent).

Site index is used to express the potential productivity of important trees on a soil. This index is determined by taking height and age measurements on selected trees within stands of a given species. The procedures and techniques for doing this are given in the site index publications used for the soil survey area *(3. 9. 11, 20. 22).* The site index applies to fully stocked, even-aged, unmanaged stands growing on a particular soil map unit. The highest yields, generally expressed in board-feet or cubic feet per acre, can be expected from map units that have the highest site indexes. Site index values can be converted into estimated yields at various ages by carefully using the appropriate yield tables (3, *4, 5, 11, 21, 22).* Important trees are listed in the same order as that of their general occurrence as observed on the map unit. Commonly, only one species will predominate.

Trees to plant are those that are planted for reforestation or, if suitable conditions exist, are allowed to regenerate naturally. Species listed are suited to the soils and can produce a commercial wood crop. Desired product, landscape position, and personal preference are three factors among many that can influence the choice of adapted trees to use in reforestation.

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 generally are 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 dwellings without basements and for local roads and streets in table 9 and interpretations for septic tank absorption fields in table 10.

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 are gently sloping 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 and horseback riding 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 Peggy A. Olds, soil conservationist, Soil Conservation Service.

The soils of the survey area support a diverse habitat for many different species of wildlife. Perhaps best known for its riverine and estaurine wetland areas, the area fulfills critical habitat needs for many species of resident and migratory waterfowl. A broad alluvial delta at the mouth of the South Fork of the Skagit River is one of the most important waterfowl wintering areas in the western part of Washington.

Surrounding agricultural lands are an important food source for many bird species. Nearly 200 species have been identified at some time of the year, including mallard, widgeon, great blue heron, grebe, osprey, red-tailed hawk, loons, gulls, and snow geese. Winter cover crops and grain stubble fields in the productive river valley provide winter feeding for many species.

The Skagit River is an important migration route for several species of salmon and sea-run trout. Gravel-bedded tributaries of the river, fed by glaciers, provide vital spawning and rearing habitat for king, silver, and sockeye salmon. Also present in the Skagit River are steelhead, cutthroat, and Dolly Varden trout. Many glacially formed lakes in the survey area have populations of bass, crappie, walleye, perch, and bullhead, which provide important recreational fishing. Mammalian wildlife species in the Skagit River valley include mink, beaver, river otter. black-tailed deer, lowland red fox, coyote, and rabbit.

Certain areas of the survey area have been designated as environmentally sensitive habitat for some wildlife species. These include the shallow water wetlands near Barney Lake, which are used by trumpeter swan populations for overwintering; a section of the southeast side of Fir Island, which is used as a snow goose feeding area; Shannon Lake, noted for the several pairs of osprey nesting in snags at the northern half of the lake; and the Samish Island Heron Rookery, near Samish Bay. An elk wintering range near Hamilton and the salt water estuaries are also critical biological areas for native wildlife species.

The upper reaches of the Skagit River have been designated as a sensitive area for bald eagles. Approximately 1,000 acres has been set aside to preserve habitat for this raptor. The eagles move into this area from late in November to early in December, following the annual salmon run up the Skagit River.

Upland areas of the survey area provide excellent habitat for numerous species of raptors and other birds. These include peregrine falcons, golden eagles, gyrfalcons, rough-legged hawks, snowy and barn owls,

ruffed grouse, and ring-necked pheasant.

Various mammalian species are present in the forested mountain areas of the survey area. Species now listed as rare that are present in these areas include cougar and high mountain red fox. Other more common species include black-tailed deer, squirrel, black bear, beaver, muskrat, opossum, porcupine, and weasel. Mountain goat may also be present. The upland areas are noted for the variety of hunting and recreational activities they provide.

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, bedstraw, and fireweed.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are red alder, bigleaf maple, black cottonwood, hawthorn, Pacific dogwood, willow, vine maple, Pacific madrone, and Oregon white oak. Examples of fruit-producing trees and shrubs that are suitable for planting on soils rated *good* are blackberry, cherry, Russian olive, mountain ash, autumn olive, apple, and crabapple.

Coniferous plants furnish browse and seeds. 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 Douglas fir, western hemlock, noble fir, and western redcedar.

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, Oregongrape, snowberry, salmonberry, 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, and cottontail.

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, 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, herons, 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 and 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 generally are 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 generally are 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 generally are 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 filter the effluent effectively. 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 because of 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 wind erosion.

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 as much as 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 generally is 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 embankments, dikes, and levees and for aquifer-fed ponds. The limitations are considered *slight* if soil properties and site features generally are 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, terraces and diversions, and grassed waterways.

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 more 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.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

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 and plasticity.

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 to 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 to 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 the content of particles coarser than sand is as much as 15 percent, an appropriate modifier is added; for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the system adopted by the American Association of State Highway and Transportation Officials (1, 12) and the Unified soil classification system (2, 12).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter 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.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6.

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 ovendry 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.

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."

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, 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.

No values for percentage of clay are given for soils that formed in material high in content of volcanic ash. The textures specified are apparent field textures. Because of the influence of volcanic ash, a complete clay dispersion is not obtained in the laboratory and therefore the clay values reported are low. The measured physical and chemical properties for these kinds of soil indicate a much higher clay content than is reported by the laboratories.

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.

Erosion factor K indicates the susceptibility of a soil

to sheet and rill erosion. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, very fine sand, sand. and organic matter (as much as 4 percent) and on soil structure and permeability. The estimates are modified by the presence of rock fragments. Values of K range from 0.00 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion.

Erosion factor T is an estimate of the maximum average 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 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 plants.

Soil and Water Features

Table 15 gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

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 excavation.

A cemented pan is a cemented subsurface layer at a depth of 5 feet or less. Such a pan causes difficulty in excavation. Pans are classified as thin or thick. In *a thin* pan, excavations can be made by trenching machines, backhoes, or small rippers. *A thick* 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 glacial till. These soils are identified in the detailed soil map unit descriptions, general soil map unit descriptions, and series descriptions as having dense glacial till layers; however, in the interpretation tables they are identified as having cemented pans. For most soil interpretations, the layer of dense glacial till is the same as a cemented pan.

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.

Table 16 gives estimates of various 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 (17).

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 sand or gravelly sand. 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 clay that has 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 covering of the soil surface by flowing water, is caused by overflow from streams, by runoff from adjacent slopes, or by inflow from high tides. Shallow water standing or flowing for short periods after rainfall or snowmelt is not considered to be flooding. Standing water in swamps and marshes or in closed depressional areas is considered to be ponding.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely to occur.

Frequency. duration, and probable period of flooding are estimated. Frequency is expressed as *none, rare, occasional.* and *frequent. None* means that flooding is not probable, *rare* that it is unlikely but is possible under unusual weather conditions (chance of flooding in any year is 0 to 5 percent), *occasional* that it occurs infrequently under normal weather conditions (chance of flooding in any year is 5 to 50 percent), and *frequent* that it occurs often under normal weather conditions (chance of flooding in any year is more than 50 percent).

Duration is expressed as *very brief* (less than 2 days), *brief (2* to 7 days), *long* (7 days to 1 month), and *very long* (more than 1 month). The time of year that flooding is most likely to occur is expressed in months. November-May, for example, means that flooding can occur during the period November through May. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information on flooding 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, which are characteristic of soils that are not subject to flooding.

Also considered are local information about the extent and level of flooding and the relation of each soil on the landscape to historic flood. 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 estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table-that is *perched* or *apparent;* and the months of the year that the water table usually is highest. A water table that is seasonally high for less than 1 month is not indicated in the table.

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. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower water table by a dry zone.

The two numbers in the column "High water table-Depth" indicate the normal range in depth to a saturated zone. Depth is given to the nearest half foot. The first numeral in the range indicates the highest water level. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. "More than 6.0" indicates that the water table is below a depth of 6 feet or that it is within a depth of 6 feet for less than a month.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (18). 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. Table 17 shows the classification of the soils in the survey area. 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,* pertaining to a river, plus *aquent,* the suborder of the Entisols that has 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 *Typic* identifies the subgroup that typifies the great group. An example is Typic 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. thickness 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 Typic 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. 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 (14).* Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (18).* 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."

Barneston Series

The Barneston series consists of very deep,

somewhat excessively drained soils on outwash terraces and terrace escarpments. These soils formed in glacial outwash, volcanic ash, and loess. Slopes are 0 to 65 percent. Elevation is 250 to 1,200 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

These soils are sandy-skeletal. mixed, mesic Andic Xerochrepts.

Typical pedon of Barneston gravelly loam, 0 to 8 percent slopes, about 2 miles northeast of Hamilton, 1,620 feet north and 860 feet east of the southwest corner sec. 6. T. 35 N., R. 7 E.

Oa-1 inch to 0; decomposed needles and twigs.

A-0 to 2 inches; black (10YR 2/1) gravelly loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine irregular pores; 20 percent rounded pebbles; medium acid; abrupt smooth boundary.

Bw1-2 to 5 inches; reddish brown (5YR 4/4) gravelly loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine roots; common fine irregular pores; 10 percent rounded shotlike aggregates; 25 percent rounded pebbles; strongly acid; clear smooth boundary.

Bw2-5 to 18 inches; dark brown (7.5YR 4/4) very gravelly loam, reddish yellow (7.5YR 6/6) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; common very fine irregular pores; 15 percent rounded shotlike aggregates; 35 percent rounded pebbles; strongly acid; abrupt wavy boundary.

2C-18 to 60 inches; yellowish brown (10YR 5/4) extremely gravelly sand, light yellowish brown (10YR 6/4) dry; single grain; loose; many fine irregular pores; 50 percent rounded pebbles and 20 percent cobbles; strongly acid.

The solum ranges from 13 to 25 inches in thickness. The profile is medium acid or strongly acid. Thickness of the influence of volcanic ash is 13 to 20 inches.

The A horizon has hue of 7.5YR or 10YR, value of 2 to 4 when moist and 4 to 6 when dry, and chroma of 1 to 3 when moist or dry. Some pedons have an E horizon. Texture is gravelly loam, very gravelly sandy loam, or very cobbly sandy loam.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 3 to 6 when moist or dry. It is very gravelly loam, very gravelly sandy loam, extremely gravelly sandy loam, very cobbly sandy loam, extremely cobbly loam, or gravelly loam. Rock fragment content averages 35 to 75 percent.

The 2C horizon has hue of 10YR, 2.5Y, or 5Y; value and chroma are highly variable. The horizon is very gravelly loamy coarse sand, extremely gravelly sand, very cobbly loamy sand, extremely cobbly coarse sand, very gravelly sand, or extremely gravelly loamy coarse sand. Rock fragment content averages 40 to 80 percent.

Bellingham Series

The Bellingham series consists of very deep, poorly drained soils in depressional areas. These soils formed in old alluvium and lacustrine material. Slopes are 0 to 3 percent. Elevation is near sea level to 450 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 170 to 210 days.

These soils are fine, mixed, nonacid, mesic Mollic Haplaquepts.

Typical pedon of Bellingham silt loam in a pasture about 10 miles north of Burlington, 2,700 feet west and 400 feet south of the northeast corner of sec. 18, T. 36 N., R. 4 E.

Ap-0 to 9 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; few very fine and fine irregular pores; medium acid; abrupt smooth boundary.

Bg1-9 to 21 inches; gray (5Y 6/1) silty clay loam, white (5Y 8/1) dry; many large prominent yellowish brown (10YR 5/4) mottles; weak medium prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; medium acid; gradual smooth boundary.

Bg2-21 to 33 inches; dark gray (5Y 4/1) silty clay, gray (5Y 6/1) dry; many medium distinct light olive brown (2.5Y 5/4) mottles; weak medium prismatic structure; very hard, firm, sticky and plastic; medium acid; gradual smooth boundary.

Cg-33 to 60 inches; dark bluish gray (5B 4/1) silty clay, bluish gray (5B 6/1) dry; common medium prominent light yellowish brown (2.5Y 6/4) mottles; massive; very hard, firm, sticky and plastic; medium acid.

The solum is 20 to 45 inches thick. The profile is medium acid to neutral throughout.

The A horizon is 6 to 10 inches thick. It is silt loam or mucky silt loam. It has hue of 10YR or 2.5Y, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 or 2 when moist or dry.

The Bg horizon has hue of 2.5Y, 5Y, or 5GY, value of 4 to 6 when moist and 5 to 8 when dry, and chroma of 1 or 2 when moist or dry. It is silty clay loam or silty clay and averages 35 to 50 percent clay.

The Cg horizon has hue of 5Y or 5B, value of 4 to 6 when moist and 5 to 8 when dry, and chroma of 1 or 2 when moist or dry. It is silty clay or clay.

Birdsview Series

The Birdsview series consists of very deep, somewhat excessively drained soils on terraces and terrace escarpments. These soils formed in glacial outwash. Slopes are 0 to 80 percent. Elevation is 200 to 1,200 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 220 days.

These soils are mixed, mesic Dystric Xeropsamments.

Typical pedon of Birdsview loamy sand, 50 to 80 percent slopes, about 3 miles southeast of Concrete, 1,550 feet north and 1,300 feet west of the southeast corner of sec. 25. T. 35 N., R. 8 E.

Oi-4 inches to 0; leaves, needles, and large wood debris.

A-0 to 5 inches; dark brown (10YR 3/3) loamy sand, yellowish brown (10YR 5/4) dry; single grain; loose; common fine roots; strongly acid; clear wavy boundary.

Bw1-5 to 30 inches; dark yellowish brown (10YR 4/4) loamy sand, light yellowish brown (10YR 6/4) dry; single grain; loose; common medium roots; strongly acid; clear wavy boundary.

Bw2-30 to 54 inches; dark yellowish brown (10YR 4/4) sand, light yellowish brown (10YR 6/4) dry; single grain; loose; very few very fine roots; medium acid; abrupt smooth boundary.

C-54 to 60 inches; olive brown (2.5Y 4/4) and olive gray (5Y 4/2) sand, light yellowish brown (2.5Y 6/4) and olive gray (5Y 4/2) dry; single grain; loose; very few very fine roots;; slightly acid.

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 3 or 4 when moist or dry. It is strongly acid to slightly acid. Some pedons have an E horizon, and some do not have an A horizon.

The B horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist or dry. It is loamy fine sand, loamy sand, or sand and is strongly acid to slightly acid.

The C horizon has hue of 10YR, 2.5Y, or 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 sand or loamy sand and is medium acid or slightly acid.

Blethen Series

The Blethen series consists of deep, well drained soils on glacially modified mountainsides. These soils formed in colluvium derived from argillite and glacial till with an admixture of volcanic ash. Slopes are 30 to 65 percent. Elevation is 200 to 1,200 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 140 to 180 days.

These soils are medial-skeletal, mesic Andic Xerochrepts.

Typical pedon of Blethen very gravelly silt loam, 30 to 65 percent slopes, 2 miles southwest of Rockport, 1,900 feet south and 1,200 feet east of the northwest corner of sec. 33, T. 35 N., R. 9 E.

Oi-3 inches to 0; undecomposed forest litter.

Bw1-0 to 12 inches; dark brown (7.5YR 4/4) very gravelly silt loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; few fine and common coarse roots; common very fine irregular pores; 35 percent angular pebbles and 10 percent angular cobbles; pH is 10.5 in sodium fluoride; strongly acid; clear wavy boundary.

Bw2-12 to 25 inches; strong brown (7.5YR 4/6) very gravelly silt loam, reddish yellow (7.5YR 6/6) dry; weak fine subangular blocky structure; soft, very friable. nonsticky and slightly plastic; weakly smeary; common fine roots; common very fine irregular pores; 35 percent angular pebbles and 10 percent angular cobbles; pH is 10.5 in sodium fluoride; strongly acid; abrupt wavy boundary.

Bw3-25 to 37 inches; dark yellowish brown (10YR 4/6) very gravelly silt loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic;

few medium roots; common very fine irregular pores; 45 percent angular pebbles and 10 percent angular cobbles; pH is 10.5 in sodium fluoride; medium acid; abrupt irregular boundary.

C-37 to 49 inches; light olive brown (2.5Y 5/6) extremely gravelly loam, yellow (2.5Y 7/6) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; very few very fine roots; common very fine irregular pores; 60 percent angular pebbles and 10 percent angular cobbles; pH is 10.5 in sodium fluoride; strongly acid; abrupt wavy boundary.

R-49 inches; argillite.

Depth to bedrock is 40 to 60 inches. The profile is strongly acid or medium acid throughout.

The Bw horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is very gravelly silt loam or very gravelly loam and averages 40 to 60 percent rock fragments. Some pedons have an A horizon.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. It averages 50 to 70 percent rock fragments.

Bow Series

The Bow series consists of very deep, somewhat poorly drained soils on broad glaciated terraces and till plains. These soils formed in gravelly glacial drift over glaciolacustrine material and have a mantle of volcanic ash. Slopes are 0 to 8 percent. Elevation is near sea level to 400 feet. The average annual precipitation is 20 to 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

These soils are fine, mixed, mesic Aquic Palexeralfs.

Typical pedon of Bow gravelly loam, 0 to 3 percent slopes. about 4 miles west of Burlington, 2,400 feet north and 80 feet west of the southeast corner of sec. 29. T. 35 N.. R. 3 E.

Ap-0 to 7 inches; dark brown (10YR 313) gravelly loam, pale brown (10YR 6/3) dry; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine discontinuous pores; 20 percent pebbles and 10 percent cobbles; neutral; clear irregular boundary.

Bw-7 to 16 inches; dark brown (7.5YR 4/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; common fine prominent gray (5Y 6/1) mottles; moderate medium and fine subangular blocky structure; soft, very friable. nonsticky and nonplastic; weakly smeary; many very fine and common fine roots; common very fine discontinuous pores; 45 percent pebbles and 5 percent cobbles; neutral; abrupt wavy boundary.

E-16 to 17 inches; grayish brown (2.5Y 5/2) very gravelly sandy loam, light gray (5Y 7/1) dry; common medium prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine discontinuous pores; 40 percent pebbles; neutral; abrupt irregular boundary.

2E/B-17 to 23 inches; 60 percent E material and 40 percent Bt material; the E part consists of 1- to 3-centimeter-thick tongues of light olive gray (5Y 6/2) silt loam, white (5Y 8/1) dry; the Bt part is grayish brown (2.5Y 5/2) clay loam, light brownish gray (2.5Y 6/2) dry, and has common medium prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; few very fine discontinuous pores; 10 percent pebbles; slightly acid; clear wavy boundary.

2B/E-23 to 31 inches; 60 percent Bt material and 40 percent E material; the Bt part is olive gray (5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; the E part consists of tongues of light olive gray (5Y 6/2) silt loam, white (5Y 8/1) dry; strong medium prismatic structure parting to strong medium angular blocky; hard, very firm, sticky and plastic; coatings of E material that are 5 to 10 millimeters thick cover 75 percent of faces of peds; common very fine roots; few very fine continuous pores; common thin clay films on faces of peds and in pores of Bt material; 5 percent pebbles; slightly acid; gradual wavy boundary.

2Btg1-31 to 48 inches; olive gray (5Y 4/2) silty clay, gray (5Y 6/1) dry; strong medium and coarse prismatic structure parting to strong medium subangular blocky; very hard, very firm, sticky and plastic; few very fine roots; few very fine and fine continuous pores; many thin clay films on faces of peds and lining pores; 5 percent pebbles; common medium prominent dark brown (7.5YR 4/4) mottles and very dark brown (10YR 2/2) manganese stains on faces of peds; few 2- to 10-millimeter-thick coatings of E material from B/E horizon extending to a depth of 36 inches on faces of peds and to a depth of 40 inches in root channels; neutral; gradual irregular boundary.

2Btg2-48 to 60 inches; olive gray (5Y 4/2) silty clay,

gray (5Y 6/1) dry; moderate coarse prismatic structure; very hard, very firm, sticky and plastic; few very fine roots; few very fine and fine continuous pores; many thin clay films on faces of peds and lining pores; 5 percent pebbles; few medium prominent dark brown (7.5YR 4/4) mottles and very dark brown (10YR 2/2) manganese stains on faces of peds; neutral.

Thickness of the influence of volcanic ash is 9 to 17 inches. Depth to the argillic horizon is 14 to 27 inches. The argillic horizon averages 35 to 50 percent clay. The profile is slightly acid or neutral throughout.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry.

The Bw horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist, and chroma of 3 to 5 when moist. It is very gravelly loam, very gravelly sandy loam, or gravelly loam and is 25 to 50 percent coarse fragments.

The E horizon has value of 4 to 6 when moist and 6 to 8 when dry, and it has chroma of 1 or 2 when moist or dry. It is very gravelly loamy sand or very gravelly sandy loam.

The E part of the E/B horizon has value of 4 to 6 when moist and 6 to 8 when dry, and it has chroma of 1 or 2 when moist or dry. The Bt part is clay loam or silty clay loam. It has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. This horizon is 0 to 15 percent coarse fragments.

The B/E horizon is silty clay loam, silty clay, or clay. The Bt part has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. The E part has value of 4 to 6 when moist and 6 to 8 when dry, and it has chroma of 1 or 2 when moist or dry. This horizon is 0 to 5 percent coarse fragments.

The Btg horizon has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 6 or 7 when dry. and chroma of 1 or 2 when moist or dry. It is silty clay or clay and is 0 to 5 percent coarse fragments.

Briscot Series

The Briscot series consists of very deep, poorly drained soils on flood plains. Drainage has been altered by tiling. These soils formed in recent alluvium. Slopes are 0 to 2 percent. Elevation is 5 to 45 feet. The average annual precipitation is about 32 inches, the average annual air temperature is about 51 degrees F. and the average frost-free season is 160 to 210 days.

These soils are coarse-loamy, mixed, nonacid, mesic Aeric Fluvaquents.

Typical pedon of Briscot fine sandy loam, about 3 miles northwest of Conway, 1,700 feet west and 1,700 feet south of the northeast corner of sec. 10, T. 33 N., R. 3 E.

Ap1-0 to 12 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak medium granular structure; soft, very friable. nonsticky and nonplastic; few very fine roots; few very fine irregular pores; slightly acid; clear smooth boundary.

Ap2-12 to 16 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; common fine irregular pores; neutral; abrupt smooth boundary.

C1-16 to 30 inches; stratified, grayish brown (2.5Y 5 2) loamy fine sand and silt loam, light gray (2.5Y 7/2) dry; common fine faint gray (10YR 6/1) and yellowish brown (10YR 5/6) mottles; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; common fine irregular pores; neutral; abrupt smooth boundary.

C2-30 to 60 inches; olive gray (5Y 5/2) silt loam, light gray (5Y 7/2) dry; common medium prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine irregular pores; few fine strata of relict plant remains 1 to 4 millimeters thick; neutral.

The 10- to 40-inch control section averages 8 to 18 percent clay and more than 15 percent fine sand or coarser. Depth to the apparent water table is 16 to 30 inches during the wet season. The profile is slightly acid or neutral throughout.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry.

The C horizon has hue of 2.5Y or 5Y, and it has value of 4 to 7 when moist or dry. It is stratified loamy fine sand to silt loam.

Cathcart Series

The Cathcart series consists of very deep, well drained soils on till plains, foothills, and mountainsides. These soils formed in glacial drift and volcanic ash and in colluvium derived from sandstone. Slopes are 8 to 65 percent. Elevation is 300 to 1,300 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 160 to 200 days.

These soils are medial. mesic Andic Xerochrepts.

Typical pedon of Cathcart loam, 8 to 15 percent slopes. about 9 miles southeast of Mount Vernon, 700 feet north and 1,900 feet west of the southeast corner of sec. 36. T. 33 N.. R. 4 E.

Oi-2 inches to 1 inch; needles,, leaves, and twigs.
Oa-1 inch to 0; decomposed forest litter.
Bw1-0 to 10 inches; reddish brown (5YR 4/4) loam, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; soft. friable, slightly sticky and slightly plastic; weakly smeary; common fine and few medium roots; few fine irregular pores; 15 percent hard rock fragments; pH is 10.5 in sodium fluoride; strongly acid; abrupt wavy boundary.
Bw2-1 0 to 18 inches; dark brown (7.5YR 4/4) loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; weakly smeary; few fine and very fine roots; common fine irregular pores; 10 percent hard rock fragments; pH is 11.0 in sodium fluoride; strongly acid; abrupt smooth boundary.
Bw3-18 to 40 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; very few very fine roots; common fine irregular pores; 15 percent hard rock fragments and 10 percent soft, weathered sandstone fragments; pH is 11.5 in sodium fluoride; strongly acid; clear smooth boundary.
C-40 to 60 inches; light olive brown (2.5Y 5/6) gravelly sandy loam, olive yellow (2.5Y 6/6) dry; massive; soft. very friable, slightly sticky and slightly plastic; weakly smeary; very few very fine roots; many fine irregular pores; 20 percent hard rock fragments and 15 percent soft, weathered sandstone fragments; pH is 12.0 in sodium fluoride; medium acid.

The A horizon is intermittent. It has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 1 to 3 when moist or dry.

The Bw horizon has hue of 5YR, 7.5YR, 10YR, or 2.5Y, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is loam. sandy loam, or silt loam. Reaction is slightly acid to strongly acid.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 7 when moist and 4 to 6 when dry. It is dominantly gravelly loam or gravelly sandy loam. In some pedons the lower part of the C horizon is influenced by siltstone and is clay loam. The C horizon averages 10 to 40 percent soft sandstone fragments. Reaction is slightly acid or medium acid.

Catla Series

The Catla series consists of shallow, moderately well drained soils on hills. These soils formed in very compact glacial till. Slopes are 0 to 15 percent. Elevation is 50 to 500 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

These soils are loamy, mixed, mesic, shallow Dystric Xerochrepts.

Typical pedon of Catla gravelly fine sandy loam, 0 to 8 percent slopes, about 5 miles south of Anacortes, 25 feet west and 2,350 feet south of the northeast corner of sec. 15, T. 34 N., R. 1 E.

Oi-1 inch to 0; forest litter of needles, leaves, and twigs.
E-0 to 2 inches; dark gray (10YR 4/1) gravelly fine sandy loam, gray (10YR 6/1) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine, medium, and coarse roots; 15 percent pebbles; strongly acid; abrupt smooth boundary.
Bw1-2 to 11 inches; dark yellowish brown (10YR 4/4) gravelly fine sandy loam, yellowish brown (10YR 5/4) dry; moderate medium and coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine, medium, and coarse roots; 35 percent pebbles; medium acid; abrupt *wavy* boundary.
Bw2-11 to 17 inches; dark yellowish brown (10YR 4/4) very gravelly loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; few coarse and medium roots; 35 percent pebbles and 10 percent cobbles; medium acid; abrupt smooth boundary.
Cr-17 to 60 inches; olive gray (5Y 5/2), dense glacial till that crushes to very cobbly loam.

Thickness of the solum and depth to the dense glacial till are 10 to 20 inches.

The E horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 1 or 2 when moist or dry. It is medium acid or strongly acid.

The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist or dry. Reaction is strongly acid or medium acid.

The Catla soils in this survey area are a taxadjunct to the Catla series because they average more than 35 percent rock fragments in the subsoil. This difference, however, does not significantly affect use and management.

Chuckanut Series

The Chuckanut series consists of deep, well drained soils on hills and mountainsides. These soils formed in volcanic ash and colluvium derived from sandstone and glacial till. Slopes are 8 to 65 percent. Elevation is 800 to 1,500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 160 to 200 days.

These soils are medial, mesic Andic Xerochrepts.

Typical pedon of Chuckanut gravelly loam, 8 to 30 percent slopes, about 5 miles southeast of Mount Vernon, 2,400 feet south and 300 feet east of the northwest corner of sec. 14, T. 33 N., R. 4 E.

Oi-7 to 2 inches; undecomposed needles, twigs, and leaves.

Oa-2 inches to 0; decomposed forest litter.

E-0 to 2 inches; dark brown (7.5YR 4/2) gravelly sandy loam, pinkish gray (7.5YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; 20 percent rounded pebbles; pH is less than 9.0 in sodium fluoride; strongly acid; abrupt wavy boundary.

Bw1-2 to 9 inches; dark yellowish brown (10YR 4/6) gravelly loam, brownish yellow (10YR 6/6) dry; weak fine subangular blocky structure parting to weak medium granular; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine roots; common medium irregular pores; 25 percent rounded pebbles and 20 percent soft sandstone fragments; pH is 11.5 in sodium fluoride; medium acid; clear wavy boundary.

Bw2-9 to 15 inches; dark yellowish brown (10YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure parting to weak medium granular; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; few coarse and common fine roots; common medium irregular pores; 25 percent rounded pebbles and 25 percent soft sandstone fragments; pH is 11.5 in sodium fluoride; medium acid; clear wavy boundary.

Bw3-15 to 35 inches; olive brown (2.5Y 4/4) gravelly sandy loam, pale yellow (2.5Y 8/4) dry; weak coarse subangular blocky structure; soft, friable, nonsticky and nonplastic; very few fine roots; few medium irregular pores; 20 percent rounded pebbles and 30 percent soft sandstone fragments; pH is 10.0 in sodium fluoride; medium acid; gradual wavy boundary.

C-35 to 49 inches; olive brown (2.5Y 4/4) gravelly loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; very few very fine roots; common very fine irregular pores; 20 percent rounded pebbles and 25 percent soft sandstone fragments; pH is 9.0 in sodium fluoride; strongly acid; abrupt smooth boundary.

Cr-49 inches; partially weathered sandstone.

Depth to partially weathered sandstone is 40 to 60 inches. The profile is medium acid or strongly acid throughout.

The E horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 to 7 when dry, and chroma of 2 or 3 when moist or dry. Some pedons have an A1 horizon.

The Bw horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 or 5 when moist and 5 to 8 when dry, and chroma of 4 to 6 when moist or dry. It is gravelly loam or gravelly sandy loam. The horizon averages 15 to 30 percent hard pebbles and is 10 to 25 percent soft sandstone fragments.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. It is gravelly loam or gravelly sandy loam. The horizon averages 15 to 25 percent hard pebbles and is 20 to 40 percent soft sandstone fragments. Some pedons do not have a C horizon.

Clallam Series

The Clallam series consists of moderately deep, moderately well drained soils on hills. These soils formed in very compact glacial till. Slopes are 0 to 15 percent. Elevation is 25 to 500 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

These soils are loamy-skeletal, mixed, mesic Dystric Xerochrepts.

Typical pedon of Clallam gravelly loam, 8 to 15

percent slopes. 2 miles west of La Conner, 1,900 feet south and 200 feet west of the northeast corner of sec. 34. T. 34 N., R. 2 E.

Oi-1 inch to 0; needles, leaves, and twigs.
A-0 to 2 inches; very dark brown (10YR 2/2) gravelly loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common fine, medium, and coarse roots; 15 percent pebbles and 10 percent cobbles; medium acid; abrupt wavy boundary.
Bw1-2 to 11 inches; dark brown (7.5YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine, medium, and coarse roots; 15 percent pebbles and 10 percent cobbles; slightly acid; abrupt irregular boundary.
Bw2-11 to 16 inches; olive brown (2.5Y 4/4) very gravelly loam, light brownish gray (10YR 6/2) dry; few fine distinct strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable, slightly sticky and nonplastic; common fine, medium, and coarse roots; 25 percent pebbles and 15 percent cobbles; slightly acid; clear wavy boundary.
C-16 to 27 inches; grayish brown (2.5Y 5/2) very gravelly loam, light brownish gray (10YR 6/2) dry; common fine distinct yellowish brown (10YR 5/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; 25 percent pebbles and 5 percent cobbles; slightly to moderately compacted; slightly acid; abrupt irregular boundary.
Cr-27 to 60 inches; olive brown (2.5Y 4/4), dense glacial till that crushes to very gravelly fine sandy loam.

Depth to dense glacial till is 20 to 40 inches. The control section averages 35 to 55 percent pebbles and cobbles. Reaction is slightly acid to strongly acid throughout.

The A horizon has value of 2 to 4 when moist and 4 to 6 when dry. and it has chroma of 2 to 4 when moist or dry.

The B horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 to 4. It is gravelly loam, very gravelly loam, or very gravelly sandy loam.

The C horizon has hue of 10YR 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.

The Cr horizon has hue of 10YR to 5Y. It is dense glacial till that crushes to very gravelly fine sandy loam or very gravelly loam. In some areas the Cr horizon is underlain by very gravelly sand or clay at a depth of less than 60 inches.

Clendenen Series

The Clendenen series consists of shallow, moderately well drained soils on glacially modified mountainsides. These soils formed in volcanic ash, loess, colluvium, and glacial till. Slopes are 3 to 65 percent. Elevation is 2,600 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 80 to 120 days.

These soils are medial-skeletal, shallow Humic Cryorthods.

Typical pedon of Clendenen gravelly silt loam, 3 to 30 percent slopes, about 13 miles east of Mount Vernon. about 2,400 feet south and 2,400 feet west of the northeast corner of sec. 21, T. 34 N., R. 6 E.

Oi-8 to 2 inches; undecomposed forest litter.
Oa-2 inches to 0; decomposed organic matter.
E-0 to 4 inches; dark reddish gray (5YR 4/2) silt loam, pinkish gray (5YR 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; many fine roots; few very fine irregular pores; 10 percent angular pebbles; pH is less than 9.0 in sodium fluoride; very strongly acid; abrupt smooth boundary.
Bhs-4 to 11 inches; dark brown (7.5YR 4/2) very gravelly loam, strong brown (7.5YR 5/6) dry; many medium dark reddish brown (5YR 3/3) organic stains on faces of peds; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; weakly smeary; very few very fine roots; very few very fine irregular pores; 45 percent angular pebbles; pH is 10.6 in sodium fluoride; strongly acid; abrupt wavy boundary.
Bs-11 to 16 inches; dark yellowish brown (10YR 4/6) very gravelly loam, reddish yellow (7.5YR 6/6) dry; few medium dark reddish brown (5YR 3/3) organic stains on faces of peds; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; very few very fine roots; few very fine irregular pores; 40 percent angular pebbles; pH is 10.5 in sodium fluoride; strongly acid; abrupt smooth boundary.
2Cr-16 to 60 inches; light gray (5Y 7/1), dense glacial till that crushes to very gravelly loam, light gray (5Y 7/1) dry; few fine distinct brownish yellow (10YR 6/6) mottles; massive; hard, firm, slightly sticky and

slightly plastic; 60 percent angular pebbles; medium acid.

Depth to dense glacial till is 14 to 20 inches. During rainy periods and spring runoff, the profile is saturated and water perches above the 2Cr horizon. The control section averages 40 to 70 percent coarse fragments.

The E horizon has hue of 5YR or 7.5YR, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry.

The matrix of the Bhs and Bs horizons has hue of 5YR, 7.5YR or 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 to 6 when moist or dry. The organic stains have hue of 2.5YR or 5YR, value of 2 to 4, and chroma of 1 to 3. The Bhs and Bs horizons are very gravelly loam, extremely gravelly loam, or very gravelly silt loam. They are very strongly acid or strongly acid.

The 2Cr horizon has hue of 10YR to 5Y, value of 4 to 7 when moist or dry, and chroma of 1 to 3 when moist or dry. It commonly is very gravelly loam or very gravelly sandy loam and is strongly acid or medium acid. Some pedons have root mats above the 2Cr horizon.

Cokedale Series

The Cokedale series consists of very deep, somewhat poorly drained soils on flood plains. These soils formed in alluvium that is high in content of phyllite. Slopes are 0 to 3 percent. Elevation is 120 to 1,200 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 200 days.

These soils are coarse-silty over sandy or sandy-skeletal. mixed, acid, mesic Aquic Xerofluvents.

Typical pedon of Cokedale silt loam, about 3 miles north of Sedro Woolley, 1,100 feet north and 600 feet west of the southeast corner of sec. 6, T. 35 N., R. 5 E.

A-0 to 4 inches; dark gray (N 4/0) silt loam, bluish gray (5B 6/1) dry; massive; soft, very friable, nonsticky and nonplastic; many fine roots; few very fine irregular pores; medium acid; clear smooth boundary.

C1-4 to 8 inches; gray (N 5/0) silt loam, bluish gray (5B 6/1) dry; few coarse prominent dark reddish brown (5YR 3/4) mottles, yellowish red (5YR 5/8) dry; massive; soft, very friable, slightly sticky and slightly plastic; many fine roots; few very fine tubular pores; strongly acid; abrupt smooth boundary.

C2-8 to 27 inches; very dark gray (5Y 3/1) silt loam, olive gray (5Y 5/2) dry; few medium prominent strong brown (7.5YR 5/8) mottles, brownish yellow (10YR 6/8) dry; massive; soft, very friable, slightly sticky and slightly plastic; many fine roots; few very fine tubular pores; strongly acid; abrupt smooth boundary.

2C3-27 to 45 inches; dark olive gray (5Y 3/2) sand, dark gray (5Y 4/1) dry; loose; many fine roots; common fine irregular pores,, strongly acid; abrupt smooth boundary.

2C4-45 to 60 inches; black (5Y 2/2) very channery loamy sand, gray (5Y 5/1) dry; loose; common fine irregular pores; 40 percent channery fragments; thin strata of loamy sand; medium acid.

Depth to sand or loamy sand is 16 to 35 inches. Depth to the fluctuating high water table is 6 to 24 inches from December to April. The upper part of the C horizon is less than 15 percent particles coarser than very fine sand.

The A horizon has hue of 5B, 5Y, 2.5Y, or N, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 0 to 2 when moist or dry.

The C horizon has hue of 5B, 5GY, 5Y, or N, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 0 to 2 when moist or dry.

The 2C horizon has hue of 5Y or 2.5Y, value of 2 to 5 when moist and 4 to 6 when dry, and chroma of 1 or 2 when moist or dry. It is loamy sand or sand above a depth of 40 inches, but it ranges to very channery loamy sand below that depth. The horizon is strongly acid or medium acid. It averages 0 to 35 percent channery fragments below a depth of 40 inches.

Coveland Series

The Coveland series consists of very deep, somewhat poorly drained soils in swales and on low hills. These soils formed in gravelly glacial drift over glaciolacustrine material. Slopes are 0 to 10 percent. Elevation is 10 to 250 feet. The average annual precipitation is about 23 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

These soils are fine, mixed, mesic Aquic Palexeralfs.

Typical pedon of a Coveland gravelly loam in a forested area of Coveland-Bow complex, 0 to 5 percent slopes; about 1 mile north of La Conner, 2,200 feet south and 2,800 feet west of the northeast corner of sec. 25, T. 34 N., R. 2 E.

Oi-1 inch to 0; needles, leaves, and twigs.

A1-0 to 4 inches; black (10YR 2/1) gravelly loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, slightly sticky and nonplastic; common very fine, fine, medium, and coarse roots; common continuous tubular pores; 5 percent cobbles and 15 percent pebbles; neutral; clear wavy boundary.

A2-4 to 9 inches; dark brown (10YR 3/3) gravelly loam, dark brown (10YR 4/3) dry; moderate coarse subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine, fine, medium, and coarse roots; common fine continuous tubular pores; 5 percent cobbles and 15 percent pebbles; neutral; abrupt smooth boundary.

E-9 to 14 inches; dark grayish brown (10YR 4/2) very gravelly sandy loam, pale brown (10YR 6'3) dry; massive; slightly hard, friable, slightly sticky and nonplastic; common very fine, fine, and medium roots; few discontinuous irregular pores; 50 percent pebbles; neutral; clear wavy boundary.

2B/E-14 to 17 inches; the Bt part is olive gray (5Y 5/2) silty clay. light olive gray (5Y 6/2) dry, and has many coarse strong brown (7.5YR 5/6) mottles; the E part is coverings of light olive gray (5Y 6/2) silt loam, light gray (5Y 7/2) dry, that are less than 2 millimeters thick and are on about 50 percent of the faces of peds; moderate medium prismatic structure parting to moderate medium subangular blocky; hard. firm, sticky and plastic; common very fine and fine roots; common very fine and fine continuous tubular pores; common thin clay films on faces of peds and lining pores; 5 percent pebbles; slightly acid; clear wavy boundary.

2Btg1-17 to 25 inches; olive gray (5Y 5/2) silty clay, light olive gray (5Y 6/2) dry; common coarse strong brown (7.5YR 5'6) mottles; moderate medium prismatic structure; hard, firm, sticky and plastic; common very fine and fine roots; few very fine continuous tubular and irregular pores; many thin clay films on faces of peds and lining pores; tongues of light olive gray (5Y 6/2) silt loam, light gray (5Y 7/1) dry, that are 2 to 3 millimeters wide and 4 to 6 centimeters long and are on faces of peds; 5 percent pebbles; slightly acid; abrupt smooth boundary.

2Btg2-25 to 40 inches; gray (5Y 5/1) silty clay, gray (5Y 6/1) dry; common medium faint gray (5Y 6/1) mottles; moderate medium prismatic structure parting to moderate medium and coarse subangular blocky; hard, firm, sticky and plastic; common very fine roots; common fine discontinuous irregular pores; many thin clay films on faces of peds; 5 percent pebbles; neutral; clear irregular boundary.

2Btg3-40 to 52 inches; dark gray (5Y 4/1) silty clay, gray (5Y 6/1) dry; common medium faint gray (5Y 6/1) mottles; weak very coarse subangular blocky structure; hard, firm, sticky and plastic; common very fine dead roots on faces of peds; common very fine continuous tubular pores; many thin clay films on faces of peds; neutral; gradual irregular boundary.

2Cg-52 to 60 inches; olive gray (5Y 4/2) silty clay, light olive gray (5Y 6/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm, sticky and plastic; neutral.

The argillic horizon is 30 to 50 inches thick and averages 35 to 50 percent clay.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 to 3 when moist or dry.

The E 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. It is very gravelly sandy loam or very gravelly sandy clay loam.

The Bt part of the 2B/E horizon is silty clay or silty clay loam. It has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. The E part has value of 4 to 6 when moist and 6 to 8 when dry, and it has chroma of 1 or 2 when moist or dry. The 2B/E horizon is 0 to 5 percent pebbles.

The 2Btg horizon has hue of 2.5Y, 5Y, or 5GY, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. It is silty clay or clay and is 0 to 5 percent pebbles.

Crinker Series

The Crinker series consists of moderately deep, well drained soils on glacially modified mountains. These soils formed in volcanic ash and glacial till and in colluvium derived from phyllite. Slopes are 3 to 65 percent. Elevation is 2,800 to 4,000 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 90 to 110 days.

These soils are medial-skeletal Typic Cryorthods.

Typical pedon of a Crinker very channery silt loam in an area of Diobsud-Crinker complex, 30 to 65 percent slopes, about 5 miles southwest of Rockport, 2,200 feet west and 2,300 feet north of the southeast corner of sec. 8, T. 34 N., R. 9E.

Oi-3 inches to 1 inch; leaves, needles, and twigs.

Oe-1 inch to 0; partially decomposed wood and leaves.
E-0 to 1 inch; grayish brown (10YR 5/2) channery silt loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; slightly hard, very friable. slightly sticky and slightly plastic; many very fine. fine, and medium roots; common very fine tubular pores; 30 percent channery fragments; pH is less than 9.4 in sodium fluoride; very strongly acid; clear wavy boundary.
Bs1-1 to 4 inches; strong brown (7.5YR 5/6) very channery silt loam, reddish yellow (7.5YR 7/6) dry; many distinct thin dark reddish brown (5YR 3/2) organic coatings on faces of peds; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; many fine and medium roots and common coarse roots; common very fine tubular pores; 40 percent channery fragments; pH is less than 9.4 in sodium fluoride; strongly acid; clear wavy boundary.
Bs2-4 to 9 inches; yellowish brown (10YR 5/6) very channery silt loam, yellow (10YR 7/6) dry; weak medium subangular blocky structure; slightly hard, very friable. slightly sticky and slightly plastic; weakly smeary; few very fine, fine, and medium roots; common very fine tubular pores; 40 percent channery fragments; pH is 10.5 in sodium fluoride; strongly acid; gradual smooth boundary.
BC-9 to 20 inches; yellowish brown (10YR 5/4) very channery loam, very pale brown (10YR 8/4) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; few very fine tubular pores; 45 percent channery fragments; pH is 10.6 in sodium fluoride; strongly acid; clear smooth boundary.
C-20 to 32 inches; light yellowish brown (2.5Y 6/4) extremely channery loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; few *very* fine tubular pores; 65 percent channery fragments and 5 percent flagstones; pH is 10.6 in sodium fluoride; medium acid; abrupt irregular boundary.
R-32 inches; phyllite.

The depth to phyllite is 20 to 40 inches. The profile is *very* strongly acid to medium acid throughout.

The Bs1 horizon has hue of 2.5YR to 7.5YR, value of 3 to 5 when moist and 5 to 8 when dry, and chroma of 3 to 6 when moist or dry.

The Bs2 and BC horizons have hue of 7.5YR or 10YR, value of 3 to 5 when moist and 5 to 8 when dry, and chroma of 4 to 6 when moist or dry. They are channery silt loam or very channery loam and are 40 to 55 percent rock fragments.

The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 4 to 6 when moist or dry. It is very channery silt loam or extremely channery loam and is 40 to 70 percent rock fragments.

Cupples Series

The Cupples series consists of moderately deep, moderately well drained soils on till plains and mountains. These soils formed in volcanic ash and glacial till. Slopes are 3 to 65 percent. Elevation is 1,000 to 2,000 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 110 to 160 days.

These soils are medial-skeletal, frigid Typic Haplorthods.

Typical pedon of Cupples gravelly silt loam, 30 to 65 percent slopes, about 3 miles northeast of Concrete, about 820 feet south and 920 feet east of the northwest corner of sec. 16, T. 36 N., R. 8 E.

Oi-7 to 4 inches; undecomposed forest litter.
Oa-4 inches to 0; decomposed forest litter.
E-0 to 2 inches; dark brown (7.5YR 4/2) gravelly silt loam, pinkish gray (7.5YR 6/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; very few fine roots and common fine roots; common very fine irregular pores; 20 percent rounded pebbles; pH is less than 9.4 in sodium fluoride; strongly acid; abrupt smooth boundary.
Bs1-2 to 8 inches; dark reddish brown (5YR 3/4) gravelly silt loam, strong brown (7.5YR 5/6) dry; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; very few fine roots; common very fine irregular pores; 20 percent rounded pebbles; pH is 10.0 in sodium fluoride; strongly acid; abrupt irregular boundary.
Bs2-8 to 18 inches; strong brown (7.5YR 5/6) very gravelly loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable. nonsticky and nonplastic; weakly smeary; very few very fine roots; common very fine irregular pores; 50 percent rounded pebbles and 10 percent cobbles; pH is 11.5 in sodium fluoride; medium acid; clear smooth boundary.

BC-18 to 34 inches; dark yellowish brown (10YR 4/4) very gravelly sandy loam, olive yellow (2.5Y 6/6) dry; weak medium granular blocky structure; soft, very friable, nonsticky and nonplastic; common fine irregular pores; 45 percent rounded pebbles and 15 percent cobbles; pH is 10.6 in sodium fluoride; medium acid; abrupt wavy boundary.

2Cr-34 to 60 inches; dark grayish brown (2.5Y 4/2), dense glacial till that crushes to very gravelly sandy loam. light brownish gray (2.5Y 6/2) dry; massive; hard, firm, nonsticky and nonplastic; 45 percent rounded pebbles; medium acid.

Depth to dense glacial till ranges from 20 to 40 inches. The profile is strongly acid or medium acid throughout.

The E horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 1 to 3 when moist or dry.

The Bs horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 3 to 6 when moist or dry. It is very gravelly silt loam, very gravelly loam, or very gravelly sandy loam.

The BC horizon has hue of 10YR or 2.5Y, 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 very gravelly loam or very gravelly sandy loam.

The 2Cr horizon has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 to 4 when moist or dry. It is dense glacial till that crushes to very gravelly loam or very gravelly sandy loam. The horizon is 40 to 60 percent rock fragments.

Diobsud Series

The Diobsud series consists of moderately deep, moderately well drained soils on glacially modified mountains. These soils formed in glacial till that is high in content of phyllite and in an admixture of volcanic ash. Slopes are 3 to 65 percent. Elevation is 2,800 to 4,200 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 38 degrees F. and the average frost-free season is 90 to 110 days.

These soils are medial Humic Cryorthods.

Typical pedon of Diobsud gravelly silt loam, 30 to 65 percent slopes, about 5 miles northeast of Sedro Woolley. about 1,160 feet south and 1,200 feet east of the northwest corner of sec. 34, T. 36 N., R. 5 E.

Oi-9 inches to 1 inch; forest litter.

Oa-1 inch to 0; decomposed forest litter; common very fine and fine roots.

E-0 to 2 inches; grayish brown (10YR 5/2) gravelly silt loam, white (10YR 8/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common very fine irregular pores; 15 percent rounded pebbles; pH is less than 9.2 in sodium fluoride; very strongly acid; abrupt smooth boundary.

Bhs-2 to 7 inches; dark reddish brown (5YR 3/4) gravelly silt loam, reddish yellow (7.5YR 6/6) dry; black (5YR 2/1) organic stains on faces of peds; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; common very fine irregular pores; 20 percent rounded pebbles; pH is 12.0 in sodium fluoride; very strongly acid; abrupt wavy boundary.

Bs-7 to 13 inches; yellowish red (5YR 4/6) gravelly silt loam, reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; common very fine irregular pores; 25 percent rounded pebbles; pH is 12.0 in sodium fluoride; strongly acid; abrupt smooth boundary.

BC-13 to 21 inches; olive (5Y 5/3) gravelly loam, pale yellow (5Y 8/3) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common very fine irregular pores; 30 percent rounded pebbles; pH is 12.0 in sodium fluoride; strongly acid; clear wavy boundary.

C-21 to 28 inches; gray (5Y 5/1) gravelly loam, white (5Y 8/2) dry; weak coarse subangular blocky structure; slightly hard, friable, sticky and slightly plastic; very few very fine roots; few very fine irregular pores; 30 percent rounded pebbles; pH is 10.0 in sodium fluoride; strongly acid; abrupt smooth boundary.

2Cr-28 to 60 inches; pale olive (5Y 6/3), dense glacial till that crushes to gravelly loam, white (5Y 8/2) dry; massive; hard, very firm, sticky and slightly plastic; very few very fine irregular pores; 30 percent pebbles; strongly acid.

Depth to dense glacial till is 20 to 40 inches. The profile is very strongly acid or strongly acid throughout.

The E horizon has hue of 7.5YR or 10YR, value of 4 to 6 when moist and 7 or 8 when dry, and chroma of 1 or 2 when moist or dry.

The matrix of the Bhs and Bs horizons has hue of 5YR or 7.5YR, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. The organic stains have hue of 2.5YR or 5YR, value of 2 or 3, and chroma of 1 or 2. The horizons are gravelly silt loam or gravelly loam and are 15 to 30 percent rock fragments.

The BC horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist and 7 or 8 when dry, and chroma of 2 or 3 when moist or dry. It is gravelly loam or gravelly silt loam and is 20 to 35 percent rock fragments.

The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 1 to 3 when moist or dry. It is gravelly loam or gravelly clay loam and is 20 to 35 percent rock fragments.

Elwell Series

The Elwell series consists of moderately deep, moderately well drained soils on glaciated mountainsides and plateaus. These soils formed in glacial till with an admixture of volcanic ash and loess. Slopes are 3 to 65 percent. Elevation is 1,000 to 2,000 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 120 to 160 days.

These soils are medial, frigid Dystric Entic Durochrepts.

Typical pedon of Elwell gravelly silt loam, 3 to 30 percent slopes, about 2 miles west of Cavanaugh Lake, 420 feet south and 600 feet east of the northwest corner of sec. 29, T. 33 N., R. 6 E.

Oi-2 inches to 0; undecomposed needles and twigs.

A-0 to 2 inches; dark brown (7.5YR 3/2) gravelly silt loam, dark brown (10YR 4/3) dry; weak fine granular structure; soft,, very friable, slightly sticky and nonplastic; weakly smeary; common very fine roots; common very fine irregular pores; 20 percent rounded pebbles; pH is 9.5 in sodium fluoride; strongly acid; clear smooth boundary.

Bw1-2 to 10 inches; dark brown (7.5YR 4/4) gravelly silt 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; common very fine irregular pores; 30 percent rounded pebbles; pH is 10.5 in sodium fluoride; strongly acid; gradual smooth boundary.

Bw2-10 to 24 inches; dark yellowish brown (10YR 3/4) gravelly silt loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common medium roots; common very fine irregular pores; 15 percent rounded pebbles; pH is 12.0 in sodium fluoride; strongly acid; clear smooth boundary.

Bw3-24 to 31 inches; dark yellowish brown (10YR 4/4) gravelly silt loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; very few very fine roots; common very fine irregular pores; 30 percent rounded pebbles and 5 percent cobbles; pH is 12.0 in sodium fluoride; strongly acid; abrupt smooth boundary.

Cqm-31 to 60 inches; pale olive (5Y 6/3), weakly cemented duripan that crushes to very gravelly loam, pale yellow (2.5Y 8/4) dry; massive; hard, very firm, slightly sticky and slightly plastic; 35 percent rounded pebbles; medium acid.

The depth to the duripan ranges from 20 to 40 inches. The control section averages 15 to 30 percent coarse fragments. The profile is medium acid or strongly acid.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 to 6 when dry. and chroma of 2 or 3 when moist or dry. Some pedons do not have an A horizon, and some have an E horizon.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is gravelly loam or gravelly silt loam.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist or dry. It is gravelly loam, gravelly sandy loam, or very gravelly loam.

Etach Series

The Etach series consists of moderately deep, somewhat excessively drained soils on glacially modified mountainsides. These soils formed in volcanic ash and coarse textured glacial till. Slopes are 30 to 65 percent. Elevation is 800 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 110 to 140 days.

These soils are sandy-skeletal, mixed, frigid Typic Haplorthods.

Typical pedon of Etach very gravelly sandy loam, 30

to 65 percent slopes, about 4 miles east of Marblemount, 800 feet north and 700 feet east of the southwest corner of sec. 14, T. 35 N., R. 11 E.

Oi-4 to 3 inches; needles and twigs.
Oa-3 inches to 0; decomposed needles and twigs.
E-0 to 8 inches; dark brown (10YR 4/3) very gravelly sandy loam, light gray (10YR 7/2) dry; weak coarse granular structure; soft, very friable, nonsticky and nonplastic; common fine roots; few very fine irregular pores; 45 percent rounded pebbles and 5 percent cobbles; very strongly acid; abrupt wavy boundary.
Bs-8 to 16 inches; dark yellowish brown (10YR 4/4) and brown (7.5YR 5/4) very gravelly sandy loam, light yellowish brown (10YR 6/4) and brownish yellow (10YR 6/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine and medium roots; common very fine irregular pores; 45 percent rounded pebbles and 5 percent cobbles; strongly acid; abrupt wavy boundary.
2C1-16 to 33 inches; light olive brown (2.5Y 5/4) very cobbly coarse sand, light yellowish brown (2.5Y 6/4) dry; weak coarse granular structure; soft, very friable. nonsticky and nonplastic; few fine roots; 20 percent rounded pebbles, 25 percent cobbles, and 10 percent stones; medium acid; abrupt wavy boundary.
2C2-33 to 36 inches; light olive brown (2.5Y 5/6) very cobbly coarse sand, olive yellow (2.5Y 6/6) dry; many medium prominent reddish brown (5YR 4/4) mottles, strong brown (7.5YR 5/6) dry; single grain; loose; few fine roots; 20 percent pebbles, 25 percent cobbles, and 5 percent stones; medium acid; abrupt wavy boundary.
2Cr-36 to 60 inches; dark yellowish brown (10YR 4/6), dense glacial till that crushes to very cobbly coarse sand. brownish yellow (10YR 6/6) dry; massive; very hard, very firm; 20 percent pebbles, 25 percent cobbles, and 5 percent stones; medium acid.

Depth to dense glacial till is 26 to 40 inches. The upper 7 to 18 inches of the profile is influenced by volcanic ash. The profile is medium acid to very strongly acid throughout.

The E horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 or 3 when moist or dry.

The Bs horizon has hue of 5YR, 7.5YR, or 10YR, 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 40 to 60 percent rock fragments, mainly pebbles.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. It is very cobbly coarse sand or very cobbly loamy coarse sand.

Fidalgo Series

The Fidalgo series consists of moderately deep, moderately well drained soils on hillsides. These soils formed in colluvium, residuum, and glacial till with an admixture of volcanic ash and loess. Slopes are 3 to 30 percent. Elevation is 20 to 1,300 feet. The average annual precipitation is about 20 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

These soils are loamy-skeletal, mixed, mesic Andic Xerochrepts.

Typical pedon of a Fidalgo gravelly loam in an area of Fidalgo-Lithic Xerochrepts-Rock outcrop complex, 3 to 30 percent slopes, about 1 mile south of Anacortes, 1,000 feet east and 1,000 feet south of the northwest corner of sec. 1, T. 34 N., R. 1 E.

Oi-1 inch to 0; needles, leaves, and twigs.
A-0 to 3 inches; very dark brown (7.5YR 2/2) gravelly loam, dark brown (7.5YR 3/2) dry; weak very fine granular structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; common very fine, fine, medium, and coarse roots; 25 percent rounded and angular pebbles and 5 percent cobbles; neutral; clear smooth boundary.
Bw1-3 to 12 inches; dark brown (7.5YR 4/2) very gravelly fine sandy loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; very weakly smeary; common very fine, fine, medium, and coarse roots; 35 percent rounded and angular pebbles; pH is 10.5 in sodium fluoride; neutral; clear irregular boundary.
Bw2-12 to 18 inches; dark brown (7.5YR 4/4) very gravelly fine sandy loam, brown (7.5YR 5/4) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; very weakly smeary; common very fine, fine, medium, and coarse roots; 45 percent angular and rounded pebbles; pH is 10.1 in sodium fluoride; neutral; clear wavy boundary.
BC-18 to 25 inches; dark brown (7.5YR 3/2) very gravelly sandy loam, dark brown (7.5YR 4/4) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine, fine, medium, and coarse roots;

50 percent angular and rounded pebbles; pH is 9.2 in sodium fluoride; neutral; clear wavy boundary.

C-25 to 29 inches; very dark brown (10YR 2/2) extremely gravelly loamy sand, dark brown (7.5YR 4/2) dry; single grain; loose; common fine, medium, and coarse roots; 65 percent angular and rounded pebbles and 1 0 percent angular cobbles; neutral; abrupt wavy boundary.

R-29 inches; hard argillite.

Depth to bedrock is 20 to 40 inches. The control section is 35 to 80 percent coarse fragments.

The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3 when moist and 3 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is slightly acid or neutral.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 or 5 when moist and 4 to 6 when dry, and chroma of 2 to 6 when moist or dry. It is very gravelly loam. very gravelly fine sandy loam, or very gravelly sandy loam and is slightly acid or neutral.

The BC horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist or dry. and chroma of 2 to 4 when moist or dry. It is very gravelly sandy loam or very gravelly fine sandy loam.

The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 2 to 4 when moist and 3 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is extremely gravelly loamy sand or very gravelly sandy loam and is slightly acid or neutral.

The bedrock is hard, unweathered argillite, serpentine, or basalt.

Field Series

The Field series consists of very deep, moderately well drained soils on flood plains. These soils formed in recent alluvium with an admixture of volcanic ash. Slopes are 0 to 3 percent. Elevation is 10 to 50 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 220 days.

These soils are medial over sandy or sandy-skeletal, mixed, nonacid. mesic Aquic Xerofluvents.

Typical pedon of Field silt loam, about 2 miles southwest of Sedro Woolley, 800 feet south and 1,450 feet west of the northeast corner of sec. 34, T. 35 N., R. 4 E.

Ap-0 to 13 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine roots; few very fine discontinuous vesicular pores; pH is 9.4 in sodium fluoride; neutral; abrupt smooth boundary.

C1-13 to 21 inches; olive (5Y 5/3) silt loam, white (5Y 8/2) and light gray (5Y 7/2) dry; common medium distinct brownish yellow (10YR 6/6) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine irregular pores; distinct discontinuous 1-inchthick layer of charcoal fragments at top of horizon; pH is 11.5 in sodium fluoride; neutral; abrupt wavy boundary.

2C2-21 to 28 inches; grayish brown (2.5Y 5/2) loamy fine sand, white (2.5Y 8/1) dry; common coarse distinct yellowish brown (10YR 5/6) mottles; massive; soft. very friable, nonsticky and nonplastic; common very fine roots; few very fine irregular pores; pH is 11.0 in sodium fluoride; neutral; abrupt smooth boundary.

2C3-28 to 40 inches; dark gray (5Y 4/1) fine sand, light gray (5Y 7/1) dry; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; few very fine roots; neutral; abrupt smooth boundary.

2C4-40 to 45 inches; gray (5Y 5/1) very fine sandy loam, white (5Y 8/1) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; very dark grayish brown (10YR 3/2) strata 1 centimeter thick; neutral; abrupt smooth boundary.

2C5-45 to 60 inches; dark gray (5Y 4/1) fine sand, white (2.5Y 8/1) dry; single grain; loose; neutral.

The upper 14 to 24 inches of the profile is influenced by volcanic ash. The profile is medium acid to neutral throughout. Depth to the apparent water table is 24 to 48 inches late in winter and early in spring.

The Ap horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist or dry.

The C1 horizon has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 3 or 4 when moist and 2 or 3 when dry. It is silt loam or very fine sandy loam.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 0 to 2 when moist or dry. It is stratified sand, fine sand, loamy fine sand, and very fine sandy loam, but it averages loamy sand or loamy fine sand above a depth of 40 inches.

Getchell Series

The Getchell series consists of moderately deep. moderately well drained soils on glaciated mountains and plateaus. These soils formed in glacial till and in volcanic ash underlain by dense glacial till. Slopes are 30 to 65 percent. Elevation is 1,800 to 2,800 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 120 days.

These soils are medial Typic Cryorthods.

Typical pedon of Getchell gravelly silt loam, 30 to 65 percent slopes, about 12 miles southeast of Rockport, 1,800 feet north and 1,200 feet east of the southwest corner of sec. 35, T. 33 N., R. 10 E.

Oi-2 inches to 1 inch; undecomposed forest litter.

Oa-1 inch to 0; decomposed forest litter.

E-0 to 1 inch; grayish brown (10YR 5/2) gravelly silt loam, light gray (10YR 7/2) dry; massive; soft, very friable. slightly sticky and slightly plastic; common fine and medium roots; common very fine irregular pores; 20 percent pebbles; pH is less than 9.4 in sodium fluoride; very strongly acid; abrupt smooth boundary.

Bs1-1 inch to 4 inches; dark reddish brown (5YR 3/4) gravelly silt loam, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; soft, very friable. slightly sticky and slightly plastic; weakly smeary; many very fine roots; common very fine irregular pores; 20 percent pebbles; pH is 12.0 in sodium fluoride; strongly acid; clear smooth boundary.

Bs2-4 to 10 inches; strong brown (7.5YR 4/6) gravelly silt loam, reddish yellow (7.5YR 6/6) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many very fine roots; common very fine irregular pores; 20 percent rounded pebbles; pH is 11.5 in sodium fluoride; strongly acid; clear smooth boundary.

Bs3-10 to 22 inches; dark brown (7.5YR 4/4) gravelly silt loam, reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; common very fine irregular pores; 20 percent pebbles; pH is 11.0 in sodium fluoride; strongly acid; clear smooth boundary.

B3-22 to 37 inches; dark yellowish brown (10YR 4/4) gravelly silt loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; common fine irregular pores; 20 percent pebbles; pH is 11.5 in sodium fluoride; strongly acid; abrupt smooth boundary.

2Cr-37 to 60 inches; grayish brown (2.5Y 5/2), dense glacial till that crushes to gravelly loam, light gray (2.5Y 7/2) dry; massive; hard, firm, slightly sticky and slightly plastic; medium acid.

Depth to dense glacial till is 20 to 40 inches. The control section averages 10 to 30 percent coarse fragments.

The E horizon has hue of 7.5YR or 10YR, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 1 to 3 when moist or dry.

The B horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 3 to 6 when moist or dry. It is gravelly silt loam or gravelly loam.

The 2Cr horizon has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 or 3 when moist or dry. It is gravelly loam or gravelly sandy loam.

Giles Series

The Giles series consists of very deep, well drained soils on terraces. These soils formed in volcanic ash and glacial outwash. Slopes are 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 51 degrees F, and the average frost-free season is 160 to 200 days.

These soils are medial, mesic Andic Xerochrepts.

Typical pedon of Giles silt loam, about 3 miles west of Concrete, 140 feet north and 840 feet west of the southeast corner of sec. 7, T. 35 N., R. 8 E.

Oi-1 inch to 0; leaves, needles, and twigs.

A-0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; common very fine irregular pores; pH is 9.4 in sodium fluoride; medium acid; abrupt smooth boundary.

E-5 to 18 inches; dark grayish brown (2.5Y 4/2) silt loam, light gray (2.5Y 7/2) dry; moderate coarse subangular blocky structure; hard, friable, slightly sticky and plastic; weakly smeary; few fine roots; common very fine tubular pores; pH is 10.1 in

sodium fluoride; medium acid; abrupt wavy boundary.

Bw1-18 to 37 inches; olive brown (2.5Y 4/4) silt loam, pale yellow (2.5Y 7/4) dry; weak coarse subangular blocky structure; hard, firm, sticky and plastic; weakly smeary; few very fine roots; common fine tubular pores; pH is 10.5 in sodium fluoride; medium acid; clear wavy boundary.

Bw2-37 to 47 inches; dark yellowish brown (10YR 4/4) silt loam. pale yellow (2.5Y 7/4) dry; weak coarse subangular blocky structure; hard, firm, sticky and plastic; weakly smeary; few very fine roots; common fine tubular pores; pH is 10.3 in sodium fluoride; medium acid; clear wavy boundary.

C-47 to 60 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; massive; hard, firm, slightly sticky and plastic; weakly smeary; very few very fine tubular pores; pH is 10.3 in sodium fluoride; strongly acid.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist or dry. Reaction is slightly acid to strongly acid.

The Bw horizon has hue of 2.5Y, 10YR, or 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 fine sandy loam or silt loam. Some pedons have strata of sand in the lower part of this horizon. Reaction is slightly acid or medium acid.

The C 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 sandy loam.

Giles Variant

The Giles Variant consists of very deep, well drained soils on terraces. These soils formed in alluvium. Slopes are 0 to 3 percent. Elevation is 500 to 600 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 140 to 170 days.

These soils are fine-silty, mixed, mesic Typic Haplumbrepts.

Typical pedon of Giles Variant silt loam, about 12 miles southeast of Rockport, about 1,100 feet south and 1,400 feet east of the northwest corner of sec. 33, T. 33 N., R. 10 E.

A1-0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

A2-6 to 15 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common fine irregular pores; medium acid; clear smooth boundary.

Bw1-15 to 27 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine tubular pores; strongly acid; clear smooth boundary.

Bw2-27 to 33 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (2.5Y 6/2) dry; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; many very fine irregular pores; strongly acid; clear smooth boundary.

Bw3-33 to 47 inches; dark brown (10YR 4/3) loam, light brownish gray (10YR 6/2) dry; weak medium prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine irregular pores; 5 percent rounded pebbles; medium acid; clear smooth boundary.

C-47 to 60 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; very few very fine roots; common very fine irregular pores; 10 percent rounded pebbles; slightly acid.

The umbric epipedon is 10 to 18 inches thick. The control section averages 20 to 35 percent clay and 5 to 15 percent sand that is coarser than very fine sand.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 to 3 when moist or dry. It is strongly acid or medium acid.

The Bw horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 2 or 3 when moist or dry. It is silt loam or silty clay loam. Reaction is medium acid or strongly acid.

The C horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 2 or 3 when moist or dry. It is silt loam, loam, or sandy loam; the lower part commonly is stratified. The horizon is medium acid or slightly acid and is 0 to 10 percent rock fragments.

Gilligan Series

The Gilligan series consists of very deep, well drained soils on terraces. These soils formed in stream alluvium and glacial outwash. Slopes are 0 to 3 percent. Elevation is 150 to 600 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 180 to 220 days.

These soils are coarse-loamy, mixed, mesic Dystric Xerochrepts.

Typical pedon of Gilligan silt loam, about 3 miles southeast of Lyman, 2,535 feet north and 1,400 feet east of the southwest corner of sec. 28, T. 35 N., R. 6 E.

Oi-1 inch to 0; needles, leaves, and twigs.
A-0 to 4 inches; dark grayish brown (10YR 4/2) silt loam. light brownish gray (10YR 6/2) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; very few very fine roots; common very fine irregular pores; strongly acid; abrupt smooth boundary.
Bw1-4 to 11 inches; yellowish brown (10YR 5/4) silt loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; very few fine roots; common very fine tubular pores; strongly acid; clear wavy boundary.
Bw2-11 to 22 inches; yellowish brown (10YR 5/6) silt loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; very few very fine roots; common very fine tubular pores; strongly acid; abrupt wavy boundary.
Bw3-22 to 32 inches; light olive brown (2.5Y 5/4) silt loam, light gray (2.5Y 7/2) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few coarse roots; few fine tubular pores; strongly acid; clear wavy boundary.
C1-32 to 47 inches; olive (5Y 4/3) sandy loam, light gray (5Y 7/2) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; very few very fine roots; few fine tubular pores; medium acid; abrupt smooth boundary.
2C2-47 to 60 inches; olive (5Y 4/3) extremely channery loamy sand, pale olive (5Y 6/3) dry; single grain; loose; many fine irregular pores; 50 percent channery fragments and 15 percent cobbles; medium acid.

The control section averages 15 to 30 percent sand that is fine or coarser and 8 to 18 percent clay.

The A horizon has hue of 10YR or 7.5YR, value of 2 to 4 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist or dry. It is strongly acid or medium acid.

The Bw horizon has hue of 2.5Y. 10YR, or 7.5YR, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 2 to 6 when moist or dry. It is silt loam or very fine sandy loam and is strongly acid or medium acid.

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 or 3 when moist or dry. It is sandy loam, loam, or silt loam and is 0 to 15 percent rock fragments.

The 2C horizon has hue of 5Y or 2.5Y. It is very channery sand, very channery loamy sand, very channery sandy loam, extremely channery sand, extremely channery loamy sand, or extremely channery sandy loam and is 40 to 65 percent coarse fragments.

Greenwater Series

The Greenwater series consists of very deep, somewhat excessively drained soils on terraces. These soils formed in sandy alluvium derived from andesite and pumice. Slopes are 0 to 3 percent. Elevation is 350 to 600 feet. The average annual precipitation is about 75 inches. the average annual air temperature is about 50 degrees F, and the average frost-free season is 130 to 170 days.

These soils are mixed, mesic Dystric Xeropsamments.

Typical pedon of Greenwater sandy loam, about 14 miles southeast of Rockport, 2,500 feet south and 600 feet east of the northwest corner of sec. 28, T. 33 N., R. 12 E.

Oi-2 inches to 1 inch; needles, twigs, and moss.
Oe-1 inch to 0; partially decomposed forest litter.
E-0 to 1 inch; brown (10YR 5/3) sandy loam, light brownish gray (10YR 6/2) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; common fine roots; strongly acid; abrupt irregular boundary.
Bw1-1 inch to 4 inches; dark brown (7.5YR 4/4) sandy loam, light brown (7.5YR 6/4) dry; weak fine granular structure; common very fine roots; soft, very friable, nonsticky and nonplastic; 5 percent pumice fragments and 10 percent pebbles; strongly acid; clear irregular boundary.
Bw2-4 to 10 inches; dark yellowish brown (10YR 4/4)

sandy loam, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; 5 percent pumice fragments and 10 percent pebbles; strongly acid; gradual smooth boundary.

Bw3-10 to 32 inches; yellowish brown (10YR 5/4) loamy sand. very pale brown (10YR 7/4) dry; massive; soft, very friable, nonsticky and nonplastic; common coarse roots; 5 percent pumice fragments and 10 percent pebbles; medium acid; clear smooth boundary.

C-32 to 60 inches; light yellowish brown (2.5Y 6/4) sand. white (2.5Y 8/2) dry; few distinct strong brown (7.5YR 5/6) mottles; single grain;, loose; very few fine roots; 15 percent fine pebbles and 5 percent pumice fragments; medium acid.

The profile is strongly acid or medium acid. It is 5 to 25 percent volcanic ash, cinders, or pumice. The control section averages less than 15 percent rock fragments.

The E horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 1 to 4 when moist or dry. It is 0 to 15 percent pumice fragments.

The Bw horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist or dry. It is loamy sand or sand below a depth of 10 inches. Iron stains are in some pedons.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 or 6 when moist and 7 or 8 when dry, and chroma of 1 to 4 when moist or dry. It commonly is loamy sand or sand; some pedons are stratified sand and silt below a depth of 40 inches. Iron stains are in some pedons.

Guemes Series

The Guemes series consists of deep, well drained soils on mountains. These soils formed in colluvium, residuum. and glacial till that are high in content of serpentine. Slopes are 8 to 70 percent. Elevation is 10 to 1,500 feet. The average annual precipitation is about 25 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

These soils are loamy-skeletal, serpentinitic, mesic Typic Haploxeralfs.

Typical pedon of Guemes very stony loam, 30 to 70 percent slopes, about 8 miles northwest of Anacortes, 1,800 feet west and 400 feet south of the northeast corner of sec. 32. T. 36 N., R. 1 E.

Oi-1 inch to 0; needles, leaves, and twigs.

E-0 to 8 inches; grayish brown (10YR 5/2) very stony loam, light gray (10YR 7/2) dry; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; 60 percent angular pebbles and 10 percent stones; neutral; clear smooth boundary.

BE-8 to 14 inches; brown (10YR 5/3) extremely gravelly loam, light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; soft, very friable, sticky and plastic; common very fine and fine roots; 70 percent angular pebbles; neutral; abrupt smooth boundary.

Bt1-14 to 32 inches; dark brown (7.5YR 4/4) extremely gravelly clay loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; few coarse and medium roots; few moderately thick clay films on faces of peds; 50 percent pebbles and 15 percent cobbles; neutral; clear smooth boundary.

Bt2-32 to 44 inches; dark yellowish brown (10YR 4/4) extremely cobbly sandy clay loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common coarse and medium roots; few thin colloidal clay films on sand grains; 40 percent pebbles and 40 percent cobbles; neutral; clear wavy boundary.

C-44 to 58 inches; olive brown (2.5Y 4/4) very gravelly loam, grayish brown (2.5Y 5/2) dry; massive; soft, very friable, slightly sticky and slightly plastic; few coarse and medium roots; 25 percent pebbles and 10 percent cobbles; neutral; clear wavy boundary.

Cr-58 to 60 inches; dense glacial till that crushes to very gravelly sandy loam; 70 percent serpentine pebbles.

Depth to dense glacial till is 40 to 60 inches. The upper 20 inches of the argillic horizon averages 60 to 85 percent rock fragments and is 25 to 35 percent clay.

The E horizon has hue of 5YR, 7.5YR, or 10YR, value of 5 or 6 when moist and 6 to 8 when dry, and chroma of 0 to 3 when moist or dry. It is slightly acid or neutral.

The BE horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 3 to 5 when moist or dry. It is extremely gravelly loam, extremely gravelly sandy loam, or very gravelly loam. Reaction is slightly acid or neutral.

The Bt horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 4 to 6 when moist or dry. It is extremely gravelly sandy clay loam, extremely gravelly clay loam, extremely cobbly clay loam, or extremely cobbly sandy clay loam

and is slightly acid or neutral. Some pedons have a BC horizon.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 2 to 5 when moist or dry. It is very gravelly sandy loam. very gravelly loam, very gravelly loamy sand, very gravelly sand, or extremely gravelly sand.

Guemes Variant

The Guemes Variant consists of moderately deep, well drained soils on glacially modified slopes and mountainsides. These soils formed in glacial till and residuum derived from serpentine. Slopes are 30 to 70 percent. Elevation is 10 to 1,500 feet. The average annual precipitation is about 25 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

These soils are loamy-skeletal, serpentinitic, mesic Typic Haploxeralfs.

Typical pedon of a Guemes Variant extremely gravelly loam in an area of Guemes Variant-Rock outcrop complex, 30 to 70 percent slopes, about 8 miles northwest of Anacortes, 1,700 feet west and 2,200 feet north of the southeast corner of sec. 29, T. 36 N., R. 1 E.

A-0 to 6 inches; dark reddish brown (2.5YR 3/4) extremely gravelly loam, reddish brown (5YR 5/4) dry; weak very fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; common very fine irregular and vesicular pores; 55 percent weathered angular pebbles and 15 percent cobbles; medium acid; gradual wavy boundary.

Bt-6 to 24 inches; dark reddish brown (5YR 3/3) extremely gravelly clay loam, reddish brown (5YR 4/4) dry, weak very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine irregular and tubular pores; common moderately thick clay films on faces of peds; 70 percent weathered angular pebbles and 15 percent cobbles; medium acid; abrupt smooth boundary.

R-24 inches; hard serpentine.

Depth to serpentine is 20 to 40 inches. The control section is 50 to 85 percent rock fragments, including pebbles, cobbles, and stones.

The A horizon has hue of 2.5YR, 5YR, or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 3 to 5 when moist or dry. It is 60 to 70 percent rock fragments and is medium acid or slightly acid.

The Bt horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 to 5 when moist or dry. It is extremely gravelly loam, extremely gravelly clay loam, or very gravelly clay loam. The horizon averages 25 to 35 percent clay and is medium acid or slightly acid.

Heisler Series

The Heisler series consists of very deep, well drained soils on glaciated mountainsides. These soils formed in glacial till influenced by phyllite and in colluvium that contains loess and volcanic ash. Slopes are 30 to 65 percent. Elevation is 200 to 1,300 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the, average frost-free season is 140 to 220 days.

These soils are medial-skeletal, mesic Andic Xerochrepts.

Typical pedon of Heisler gravelly silt loam, 30 to 65 percent slopes, about 4 miles southwest of Lyman, 2,000 feet north and 500 feet west of the southeast corner of sec. 31, T. 35 N., R. 6 E.

Oi-1 to 0.5 inch; undecomposed needles, leaves, and twigs.

Oa-0.5 inch to 0; decomposed organic matter; abrupt wavy boundary.

Bw1-0 to 8 inches; dark reddish brown (5YR 3/4) gravelly silt loam, brown (10YR 5/3) dry; weak fine granular structure; loose, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots and common fine and medium roots; many very fine and common fine vesicular pores; 15 percent pebbles; pH is 10.5 in sodium fluoride; strongly acid; clear wavy boundary.

Bw2-8 to 20 inches; dark brown (7.5YR 3/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium roots; common very fine and fine irregular pores; 25 percent pebbles and 10 percent cobbles; pH is 10.5 in sodium fluoride; strongly acid; abrupt wavy boundary.

2C1-20 to 28 inches; light yellowish brown (2.5Y 6/4) very gravelly sandy loam, pale yellow (5Y 7/3) dry; weak medium subangular blocky structure parting to moderate fine granular; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; few fine

and very fine irregular pores; 30 percent pebbles and 10 percent cobbles; pH is 12.0 in sodium fluoride; medium acid; abrupt smooth boundary.

2C2-28 to 60 inches; light gray (2.5Y 7/2) very gravelly loam, white (5Y 8/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine irregular pores; 35 percent pebbles and 10 percent cobbles; pH is 11.5 in sodium fluoride; medium acid.

Thickness of the solum and depth to unconsolidated till range from 15 to 25 inches. The control section averages 35 to 55 percent rock fragments. The profile is strongly acid or medium acid.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist and 3 or 4 when dry. It is gravelly silt loam or very gravelly loam. Some pedons have a thin A or E horizon.

The 2C horizon has hue of 2.5Y or 5Y, value of 5 to 7 when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist or dry. It is very gravelly loam or very gravelly sandy loam.

Hoogdal Series

The Hoogdal series consists of very deep, moderately well drained soils on terraces and terrace escarpments. These soils formed in loess and glaciolacustrine sediment. Slopes are 8 to 60 percent. Elevation is 100 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 160 to 200 days.

These soils are fine, mixed, mesic Aquic Dystric Xerochrepts.

Typical pedon of Hoogdal silt loam, 15 to 30 percent slopes, about 5 miles northeast of Sedro Woolley, 1,600 feet south and 2,400 feet east of the northwest corner of sec. 3. T. 35 N.. R. 5 E.

Oi-1 inch to 0; needles and twigs.

A-0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; soft, very friable. slightly sticky and slightly plastic; common fine roots and few medium and coarse roots; common very fine irregular pores; medium acid; abrupt wavy boundary.

Bw1-6 to 11 inches; yellowish brown (10YR 5/4) silty clay loam, very pale brown (10YR 7/3) dry; weak medium subangular blocky structure; slightly hard, friable. sticky and plastic; common fine roots and few medium and coarse roots; common very fine irregular pores; medium acid; clear smooth boundary.

Bw2-11 to 16 inches; light yellowish brown (2.5Y 6/4) silty clay, white (10YR 8/2) dry; weak coarse subangular blocky structure; slightly hard, very friable, sticky and plastic; common fine roots; few fine tubular pores and common very fine irregular pores; medium acid; clear smooth boundary.

Bw3-16 to 21 inches; olive (5Y 5/3) silty clay, white (5Y 8/2) dry; common fine faint light yellowish brown (2.5Y 6/4) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and very plastic; common fine roots; few fine tubular pores; medium acid; clear smooth boundary.

Bw4-21 to 28 inches; olive gray (5Y 5/2) silty clay, light gray (5Y 7/2) dry; few fine faint light yellowish brown (2.5Y 6/4) mottles; weak coarse prismatic structure parting to weak coarse subangular blocky; hard, firm, sticky and very plastic; few very fine and fine roots; few very fine tubular pores; medium acid; clear smooth boundary.

C-28 to 60 inches; olive gray (5Y 5/2) clay, pale yellow (5Y 7/3) dry; massive; hard, firm, very sticky and very plastic; very few fine irregular pores; medium acid.

The profile is 0 to 15 percent coarse fragments. Some pedons have lenses of fine sand or sand in the control section.

The A horizon has value of 3 or 4 when moist and 5 or 6 when dry, and it has chroma of 2 or 3 when moist or dry.

The Bw horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist or dry. It is silt loam, silty clay loam, or silty clay.

The C horizon has value of 5 or 6 when moist and 6 to 8 when dry, and it has chroma of 2 or 3 when moist or dry. It is silty clay or clay.

Humskel Series

The Humskel series consists of moderately deep, well drained soils on glacially modified mountains. These soils formed in volcanic ash and colluvium derived from metasedimentary rock. Slopes are 3 to 65 percent. Elevation is 3,200 to 4,500 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 38 degrees F, and the average frost-free season is 70 to 100 days.

These soils are medial-skeletal Humic Cryorthods.

Typical pedon of Humskel gravelly sandy loam, 30 to 65 percent slopes, about 6 miles northwest of Concrete, about 1,960 feet south and 1,135 feet west of the northeast corner of sec. 7, T. 36 N.. R. 8 E.

Oi-1 inch to 0; needles, bark, and twigs.

E-0 to 2 inches; dark brown (7.5YR 3/2) gravelly sandy loam, pinkish gray (7.5YR 6/2) dry; weak medium subangular blocky structure; soft, friable, nonsticky and slightly plastic; few fine roots; few fine irregular pores; 20 percent angular pebbles; pH is 9.2 in sodium fluoride; very strongly acid; abrupt smooth boundary.

Bhs-2 to 9 inches; dark reddish brown (5YR 3/3) very gravelly sandy loam, dark reddish brown (5YR 3/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; few fine roots; few very fine irregular pores; 40 percent angular pebbles; pH is 12.0 in sodium fluoride; very strongly acid; clear wavy boundary.

Bs1-9 to 17 inches; strong brown (7.5YR 4/6) very gravelly sandy loam, strong brown (7.5YR 5/6) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; many fine irregular pores; 45 percent angular pebbles and 10 percent cobbles; pH is 12.0 in sodium fluoride; strongly acid; clear smooth boundary.

Bs2-17 to 23 inches; dark reddish brown (5YR 3/4) very gravelly sandy loam, strong brown (7.5YR 4/6) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine roots; many fine irregular pores; 50 percent angular pebbles and 10 percent cobbles; pH is 10.5 in sodium fluoride; very strongly acid; abrupt smooth boundary.

R-23 inches; fractured, hard argillite.

Depth to argillite is 20 to 40 inches. The profile is very strongly acid or strongly acid throughout.

The E horizon has hue of 5YR 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. Some pedons do not have an E horizon.

The Bhs horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist or dry, and chroma of 3 or 4 when moist or dry. It is very gravelly loam or very gravelly sandy loam.

The Bs horizon has hue of 5YR. 7.5YR, or 10YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 4 to 6 when moist or dry. It is very gravelly sandy loam or very gravelly loam.

Illabot Series

The Illabot series consists of moderately deep, moderately well drained soils on glacially modified mountainsides. These soils formed in glacial till and volcanic ash. Slopes are 3 to 65 percent. Elevation is 1,000 to 2,200 feet. The average annual precipitation is about 75 inches. the average annual air temperature is about 44 degrees F, and the average frost-free season is 120 to 150 days.

These soils are loamy-skeletal, mixed, frigid Andic Xerochrepts.

Typical pedon of Illabot very gravelly loam, 3 to 30 percent slopes, about 1 mile east of Concrete, 205 feet north and 1,850 feet east of the southwest corner of sec. 1. T. 35 N., R. 8 E.

Oi-3 inches to 1 inch; undecomposed litter of needles, twigs, and roots.

Oe-1 inch to 0; partially decomposed forest litter.

A-0 to 3 inches; dark brown (10YR 4/3) very gravelly loam, very pale brown (10YR 7/3) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common fine roots; common very fine irregular pores; 45 percent rounded pebbles and 5 percent cobbles; pH is 10.0 in sodium fluoride; medium acid; abrupt wavy boundary.

Bw1-3 to 9 inches; yellowish brown (10YR 5/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common fine roots; common fine irregular pores; 45 percent rounded pebbles and 5 percent cobbles; pH is 10.0 in sodium fluoride; medium acid; abrupt wavy boundary.

2Bw2-9 to 30 inches; light olive brown (2.5Y 5/4) very gravelly loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common fine irregular pores; 45 percent rounded pebbles and 5 percent cobbles; pH is 10.0 in sodium fluoride; medium acid; abrupt wavy boundary.

2Cr-30 to 60 inches; olive brown (2.5Y 4/4), dense glacial till that crushes to very gravelly sandy loam, pale olive (5Y 6/3) dry; massive; very hard, very firm, slightly sticky and slightly plastic; few very fine

tubular pores; 45 percent rounded pebbles and 5 percent cobbles; medium acid.

Thickness of the solum and depth to dense glacial till are 20 to 40 inches. Thickness of the influence of ash is 8 to 14 inches. The profile is strongly acid or medium acid throughout.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 3 or 4 when moist or dry.

The Bw horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 4 or 5 when moist or dry. It is very gravelly loam or very gravelly sandy loam and is 6 to 15 percent clay. The horizon averages 40 to 60 percent rock fragments.

The 2Cr horizon has hue of 2.5Y or 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 dense glacial till that crushes to very gravelly sandy loam or very gravelly loam. The horizon is 5 to 12 percent clay and averages 40 to 60 percent rock fragments.

Indianola Series

The Indianola series consists of very deep, somewhat excessively drained soils on outwash terraces. These soils formed in sandy glacial drift. Slopes are 0 to 5 percent. Elevation is 50 to 600 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 50 degrees F. and the average frost-free season is 160 to 210 days.

These soils are mixed, mesic Dystric Xeropsamments.

Typical pedon of Indianola sandy loam, 0 to 5 percent slopes. about 1 mile north of Lyman, 100 feet east and 2,500 feet south of the northwest corner of sec. 9. T. 35 N., R. 6 E.

Oi-2 inches to 0; forest litter.

A-0 to 6 inches; very dark brown (10YR 2/2) sandy loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; very friable, soft, nonsticky and nonplastic; few very fine roots; strongly acid; abrupt wavy boundary.

Bw1-6 to 11 inches; dark brown (7.5YR 4/3) loamy fine sand, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; very friable, soft, nonsticky and nonplastic; few very fine roots; strongly acid; abrupt wavy boundary.

Bw2-11 to 15 inches; dark brown (7.5YR 4/4) loamy sand, olive yellow (2.5Y 6/6) dry; weak fine subangular blocky structure; very friable, soft, nonsticky and nonplastic; few fine roots; strongly acid; clear wavy boundary.

Bw3-15 to 29 inches; dark yellowish brown (10YR 4/4) loamy sand. light yellowish brown (2.5Y 6/4) dry; weak coarse subangular blocky structure; very friable, soft, nonsticky and nonplastic; few fine roots; strongly acid; clear wavy boundary.

C-29 to 60 inches; yellowish brown (10YR 5/4) sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; very few very fine roots; strongly acid.

The control section averages less than 15 percent rock fragments, The profile is medium acid or strongly acid throughout.

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 Bw horizon has hue of 2.5Y, 10YR, or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist and 4 to 6 when 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 chroma of 2 to 4 when moist or dry.

Jackman Series

The Jackman series consists of very deep, well drained soils on glacially modified mountainsides. These soils formed in volcanic ash and in colluvium and glacial till derived from dunite. Slopes are 30 to 65 percent. Elevation is 2,500 to 4,200 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 90 to 110 days.

These soils are loamy-skeletal, serpentinitic Andic Cryochrepts.

Typical pedon of Jackman gravelly loam, 30 to 65 percent slopes, about 5 miles northwest of Concrete, 1,505 feet north and 2,430 feet east of the southwest corner of sec. 19, T. 36 N., R. 8 E.

Oi-4 inches to 0; undecomposed forest litter.

Bs1-0 to 4 inches; strong brown (7.5YR 4/6) gravelly loam, reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine roots; common very fine irregular pores; 30 percent rounded pebbles; strongly acid; clear wavy boundary.

Bs2-4 to 15 inches; dark yellowish brown (10YR 4/6)

very gravelly loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable. slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; common very fine irregular pores; 30 percent rounded pebbles and 10 percent cobbles; very strongly acid; abrupt wavy boundary.

C1-15 to 27 inches; olive brown (2.5Y 4/4) very gravelly loam, light yellowish brown (2.5Y 6/4) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine irregular pores; 35 percent rounded pebbles and 10 percent cobbles; strongly acid; clear wavy boundary.

C2-27 to 60 inches; olive (5Y 4/3) very gravelly sandy loam, pale olive (5Y 6/3) dry; massive; soft, friable, nonsticky and nonplastic; common fine irregular pores; 40 percent rounded pebbles and 10 percent cobbles; very strongly acid.

The profile is very strongly acid or strongly acid throughout.

The Bs horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 or 5 when moist and 5 or 6 when dry. and chroma of 4 to 6 when moist or dry. It is gravelly loam, very gravelly loam. or very gravelly silt loam and is 30 to 45 percent rock fragments.

The C horizon has hue of 10YR, 2.5Y, or 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 very gravelly sandy loam or very gravelly loam and is 40 to 60 percent rock fragments.

Jug Series

The Jug series consists of very deep, somewhat excessively drained soils on terraces. These soils formed in volcanic ash and glacial outwash. Slopes are 0 to 30 percent. Elevation is 1,000 to 1,800 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F. and the average frost-free season is 100 to 120 days.

These soils are sandy-skeletal, mixed, frigid Humic Haplorthods.

Typical pedon of Jug very gravelly loam, 0 to 30 percent slopes, about 2 miles northeast of Cavanaugh Lake, 1,100 feet south and 1,300 feet west of the northeast corner of sec. 13, T. 33 N., R. 6 E.

Oi-4 inches to 1 inch; undecomposed forest litter.

Oa-1 inch to 0; decomposed forest litter.

E-0 to 2 inches; dark brown (7.5YR 4./2) gravelly loam, pinkish gray (7.5YR 7/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; very few very fine irregular pores; 30 percent rounded pebbles; very strongly acid; abrupt wavy boundary.

Bhs-2 to 7 inches; strong brown (7.5YR 4/6) very gravelly loam, reddish yellow (7.5YR 6/6) dry; many coarse dark reddish brown (5YR 3/2) organic stains on faces of peds; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few fine roots; few very fine irregular pores; 40 percent rounded pebbles and 15 percent cobbles; very strongly acid; abrupt wavy boundary.

Bs1-7 to 16 inches; strong brown (7.5YR 4/6) extremely cobbly sandy loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine roots; few fine irregular pores; 40 percent rounded pebbles and 30 percent cobbles; strongly acid; clear wavy boundary.

2C1-16 to 40 inches; dark yellowish brown (10YR 4/6) extremely cobbly loamy sand, brownish yellow (10YR 6/6) dry; single grain; loose; very few very fine roots; many fine irregular pores; 40 percent rounded pebbles and 30 percent cobbles; strongly acid; abrupt irregular boundary.

2C2-40 to 60 inches; dark yellowish brown (10YR 4/6) extremely cobbly sand, brownish yellow (10YR 6/6) dry; single grain; loose; common fine irregular pores;; 45 percent rounded pebbles and 30 percent cobbles; strongly acid.

The bulk density of the profile to a depth of 14 to 20 inches is 0.85 to 0.95 grams per cubic centimeter. The profile is very strongly acid or strongly acid throughout. The depth of influence of volcanic ash is 14 to 20 inches.

The E horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 2 or 3 when moist or dry. It is 15 to 45 percent pebbles and cobbles.

The matrix of the Bhs horizon has hue of 7.5YR or 5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. The organic stains have hue of 2.5YR or 5YR, value of 2 to 4, and chroma of 2 or 3. The Bhs horizon is 40 to 60 percent pebbles and cobbles.

The Bs horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. It is very cobbly sandy loam,

extremely cobbly sandy loam, very cobbly loam, or extremely cobbly loam and is 40 to 70 percent pebbles and cobbles.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. It is very cobbly sand, extremely cobbly sand. very cobbly loamy sand. or extremely cobbly loamy sand and is 45 to 75 percent pebbles and cobbles.

Keystone Series

The Keystone series consists of very deep, excessively drained soils on kames, moraines, and outwash plains. These soils formed in sandy glacial drift. Slopes are 0 to 30 percent. Elevation is near sea level to 300 feet. The average annual precipitation is about 23 inches. the average annual air temperature is about 51 degrees F, and the average frost-free season is 180 to 220 days.

These soils are mixed, mesic Dystric Xeropsamments.

Typical pedon of Keystone loamy sand, 0 to 8 percent slopes, about 2 miles south of Anacortes, 1,400 feet east and 20 feet north of the southwest corner of sec. 30. T. 35 N., R. 2 E.

Oe-1 inch to 0; partially decomposed needles. leaves, and twigs.

A-0 to 3 inches; very dark brown (10YR 2/2) sandy loam. dark gray (10YR 4/1) dry; moderate medium granular structure; soft, friable, nonsticky and nonplastic; many fine, medium, and coarse roots; 5 percent pebbles; slightly acid; abrupt wavy boundary.

Bw-3 to 15 inches; dark yellowish brown (10YR 4/4) loamy sand, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common medium and coarse roots; 10 percent pebbles; slightly acid; clear wavy boundary.

C1-15 to 38 inches; light olive brown (2.5Y 5/4) and grayish brown (2.5Y 5/2) sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; few medium and coarse roots; 5 percent pebbles; slightly acid; clear wavy boundary.

C2-38 to 60 inches; olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/4) sand, light gray (2.5Y 7/2) dry; single grain; loose; 5 percent pebbles; slightly acid.

The control section averages 5 to 25 percent pebbles.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 4 to 6 when dry, and chroma of 1 to 3 when moist or dry. It is medium acid or slightly acid. Some pedons have a thin E horizon.

The Bw horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 2 to 5 when moist or dry. It is loamy sand, sand, gravelly sand, or gravelly loamy sand and is medium acid or slightly acid.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry. It is sand or gravelly sand.

Kindy Series

The Kindy series consists of moderately deep, moderately well drained soils on glaciated mountains. These soils formed in volcanic ash, loess, colluvium, and glacial till. Slopes are 3 to 65 percent. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 90 to 120 days.

These soils are medial-skeletal Typic Cryorthods.

Typical pedon of Kindy gravelly silt loam, 30 to 65 percent slopes, about 3 miles south of Lyman, 2,400 feet south and 2,400 feet west of the northeast corner of sec. 29, T. 35 N., R. 6 E.

Oi-2.5 inches to 0.5 inch; needles and twigs.

Oa-0.5 inch to 0; decomposed forest litter.

E-0 to 4 inches; pinkish gray (5YR 6/2) gravelly silt loam, pinkish gray (7.5YR 7/2) dry; massive; soft, friable, slightly sticky and slightly plastic; few fine and common very fine roots; few very fine irregular pores; 25 percent pebbles; pH is less than 9.2 in sodium fluoride; very strongly acid; abrupt smooth boundary.

Bs1-4 to 7 inches; reddish brown (5YR 4/4) gravelly silt loam, dark yellowish brown (10YR 4/6) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; few fine irregular pores; 25 percent pebbles; pH is 12.0 in sodium fluoride; strongly acid; clear smooth boundary.

Bs2-7 to 10 inches; strong brown (7.5YR 5/8) gravelly loam, brownish yellow (10YR 6/6) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots and few medium roots; common fine irregular pores; 25 percent

pebbles; pH is 12.0 in sodium fluoride; strongly acid; clear smooth boundary.

BC-10 to 24 inches; dark yellowish brown (10YR 4/6) very gravelly loam, brownish yellow (10YR 6/6) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; few fine irregular pores; 50 percent pebbles; pH is 12.0 in sodium fluoride; strongly acid; clear smooth boundary.

2C-24 to 34 inches; dark grayish brown (2.5Y 4/2) very gravelly loam, light brownish gray (2.5Y 6/2) dry; weak medium subangular blocky structure and moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; very few fine roots; common fine irregular pores; 60 percent pebbles; pH is 11.0 in sodium fluoride; strongly acid; abrupt smooth boundary.

2Cr-34 to 60 inches; olive brown (2.5Y 4/4), dense glacial till that crushes to very gravelly loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct strong brown (7.5YR 4/6) mottles; massive; very hard, firm, slightly sticky and slightly plastic; 45 percent angular pebbles; strongly acid.

Depth to dense glacial till is 20 to 40 inches. The control section averages 30 to 45 percent sand and 35 to 60 percent rock fragments. The profile is very strongly acid or strongly acid throughout.

The E horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist or dry.

The Bs horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 4 to 8 when moist or dry. It is gravelly silt loam, gravelly loam, very gravelly silt loam, or very gravelly loam and is 20 to 45 percent rock fragments.

The BC horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 to 6 when moist and 5 or 6 when dry. It is very gravelly loam or very gravelly silt loam and is 35 to 60 percent rock fragments.

The 2C horizon has hue of 2.5Y or 10YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. It is very gravelly loam or very gravelly sandy loam.

Klawatti Series

The Klawatti series consists of moderately deep, well drained soils on mountainsides and ridgetops. These soils formed in colluvium derived from dunite and volcanic ash. Slopes are 30 to 65 percent. Elevation is 3,200 to 4,200 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 40 degrees F, and the average frost-free season is 85 to 105 days.

These soils are loamy-skeletal, serpentinitic Andic Cryochrepts.

Typical pedon of Klawatti gravelly loam, 30 to 65 percent slopes, about 4 miles northwest of Concrete, 1,030 feet north and 2,330 feet east of the southwest corner of sec. 19, T. 36 N., R. 8 E.

Oi-7 inches to 0; undecomposed forest litter.

Bs1-0 to 6 inches; yellowish red (5YR 4/6) gravelly loam, yellowish red (5YR 5/6) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; very few very fine roots; common very fine irregular pores; 20 percent angular pebbles; strongly acid; gradual wavy boundary.

Bs2-6 to 19 inches; strong brown (7.5YR 4/6) very cobbly loam, strong brown (7.5YR 5/6) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; very few very fine roots; common very fine irregular pores; 25 percent angular pebbles and 20 percent cobbles; pH is 10.0 in sodium fluoride; strongly acid; clear wavy boundary.

BC-19 to 28 inches; strong brown (7.5YR 4/6) very gravelly loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine irregular pores; 30 percent angular pebbles and 10 percent cobbles; pH is 10.1 in sodium fluoride; strongly acid; abrupt smooth boundary.

R-28 inches; dunite.

Depth to dunite and thickness of the volcanic ash influence are 20 to 40 inches. The control section averages 40 to 70 percent rock fragments. Some pedons have an E horizon. The profile is strongly acid to slightly acid.

The *Bs* horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry; and chroma of 3 to 6 when moist or dry. It is gravelly loam, very gravelly loam, cobbly loam, or very cobbly loam and is 20 to 45 percent rock fragments.

The *BC* horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of

4 to 6 when moist or dry. It is very gravelly loam, extremely gravelly loam, cobbly loam, or extremely cobbly loam and is 30 to 50 percent pebbles and 5 to 20 percent cobbles.

Kline Series

The Kline series consists of very deep, somewhat excessively drained soils on alluvial fans, These soils formed in mixed alluvium. Slopes are 0 to 8 percent. Elevation is 100 to 1,000 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 140 to 170 days.

These soils are sandy-skeletal, mixed, mesic Aquic Xerofluvents.

Typical pedon of Kline very gravelly sandy loam, 0 to 8 percent slopes, about 2 miles east of Rockport, 1,400 feet west and 2,000 feet south of the northeast corner of sec. 30. T. 35 N., R. 10 E.

Oi-1 inch to 0; undecomposed forest litter.

A-0 to 3 inches; black (10YR 2/1) very gravelly sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine, fine, medium. and coarse roots; 55 percent angular pebbles; neutral; clear smooth boundary.

C1-3 to 15 inches; very dark gray (10YR 3/1) extremely gravelly foamy sand, dark grayish brown (10YR 4/2) dry; single grain; loose; common fine and medium roots; 65 percent pebbles and 10 percent cobbles; neutral; clear smooth boundary.

C2-15 to 19 inches; very dark gray (10YR 3/1) extremely gravelly sand, dark gray (10YR 4/1) dry; single grain; loose; few fine roots; few very fine wood fragments; 65 percent pebbles and 10 percent cobbles; neutral;; gradual smooth boundary.

C3-19 to 60 inches; dark gray (10YR 4/1) extremely gravelly sand, gray (10YR 5/1) dry; single grain; loose; 75 percent pebbles and 10 percent cobbles; neutral.

The A horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 2 to 4 when moist and 3 to 5 when dry, and chroma of 1 to 3 when moist or dry. It is 35 to 60 percent rock fragments.

The C horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 1 or 2 when moist or dry. It is stratified extremely gravelly loamy sand, extremely gravelly sand, or very cobbly sand and is 50 to 90 percent rock fragments.

Laconner Series

The Laconner series consists of moderately deep, moderately well drained soils on till plains and terraces. These soils formed in coarse textured glacial drift with an admixture of volcanic ash over dense glacial till. Slopes are 0 to 15 percent. Elevation is 100 to 400 feet. The average annual precipitation is about 22 inches, the average annual air temperature is about 50 degrees F. and the average frost-free season is 160 to 210 days.

These soils are sandy-skeletal, mixed, mesic Aquic Xerorthents.

Typical pedon of Laconner very gravelly loamy sand, 0 to 8 percent slopes, about 2 miles southwest of Anacortes, 2,600 feet west and 300 feet north of the southeast corner of sec. 35, T. 35 N., R. 1 E.

Oi-0.5 inch to 0; needles, leaves, and twigs.

A-0 to 2 inches; very dark brown (10YR 2/2) gravelly sandy loam, dark gray (10YR 4/1) dry; weak very fine granular structure; soft, *very* friable, nonsticky and nonplastic; common very fine, fine, medium, and coarse roots; 20 percent pebbles; pH is 9.0 in sodium fluoride; slightly acid; abrupt smooth boundary.

Bw1-2 to 9 inches; dark brown (10YR 4/3) very gravelly loamy sand, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine, fine, medium, and coarse roots; 60 percent pebbles; pH is 9.4 in sodium fluoride; medium acid; clear wavy boundary.

Bw2-9 to 19 inches; dark yellowish brown (10YR 4/4) very gravelly loamy sand, light yellowish brown (10YR 6/4) dry; single grain; loose; few medium and coarse roots; 65 percent pebbles; pH is 10.0 in sodium fluoride; medium acid; clear wavy boundary.

C1-19 to 32 inches; dark grayish brown (2.5Y 4/2) very gravelly sand, light olive brown (2.5Y 5/4) dry; single grain; loose; few medium and coarse roots; 40 percent pebbles; pH is 10.0 in sodium fluoride; neutral; clear wavy boundary.

C2-32 to 38 inches; light olive brown (2.5Y 5/4) very gravelly loamy sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; few medium and coarse roots; 65 percent pebbles and few dense glacial till fragments; pH is 9.4 in sodium fluoride; neutral; abrupt smooth boundary.

2Cr-38 to 55 inches; grayish brown (2.5Y 5/2), dense glacial till that crushes to very gravelly fine sandy loam; 35 percent pebbles; abrupt smooth boundary.

3C3-55 to 60 inches; light olive brown (2.5Y 5/4) very gravelly loamy sand, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; 40 percent pebbles; neutral.

Depth to dense glacial till is 25 to 40 inches. These soils have an admixture of volcanic ash that is 7 to 25 inches thick and is either too weak or too thin to be medial. The control section is 35 to 65 percent coarse fragments. The profile is medium acid to neutral throughout.

The A horizon has hue of 7.5YR or 10YR, value of 1 to 3 when moist and 2 to 6 when dry, and chroma of 0 to 3 when moist or dry.

The Bw horizon have hue of 5YR, 7.5YR, or 10YR, value of 4 to 6 when moist or dry, and chroma of 3 to 5 when moist or dry. It is very gravelly loamy sand or very gravelly sand.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry. It is very gravelly loamy sand or very gravelly sand.

The Cr horizon is dense glacial till that crushes to very gravelly fine sandy loam, very gravelly sandy loam, very gravelly loamy fine sand, or very gravelly loamy sand.

Larush Series

The Larush series consists of very deep, well drained soils on terraces and flood plains. These soils formed in mixed alluvium. Slopes are 0 to 5 percent. Elevation is 100 to 500 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 52 degrees F. and the average frost-free season is 180 to 220 days.

These soils are coarse-silty over sandy or sandy-skeletal, mixed, mesic Fluventic Xerumbrepts.

Typical pedon of Larush silt loam, about 2 miles southwest of Rockport, 1,980 feet north and 920 feet east of the southwest corner of sec. 36, T. 35 N., R. 9 E.

Oi-1 inch to 0; deciduous leaves and twigs.

A1-0 to 4 inches. very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; common fine faint very dark gray (10YR 3/1) organic stains on faces of peds; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common very fine roots; common fine and medium tubular pores; strongly acid; abrupt wavy boundary.

A2-4 to 15 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; few fine faint very dark gray (10YR 3/1) organic stains on faces of peds; weak coarse subangular blocky structure;, soft, very friable, nonsticky and slightly plastic; few fine roots; common fine and medium tubular pores; strongly acid; abrupt wavy boundary.

Bw-15 to 24 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; few fine faint dark grayish brown (10YR 4/2) organic stains on faces of peds; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common medium roots; few fine and medium tubular pores; strongly acid; abrupt wavy boundary.

2C1-24 to 41 inches; dark grayish brown (2.5Y 4/2) and white (N 5/0) fine sand, grayish brown (2.5Y 5/2) dry; single grain; loose; few very fine roots; medium acid; abrupt wavy boundary.

3C2-41 to 60 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; massive; soft. very friable, slightly sticky and slightly plastic; few fine roots; thin strata of fine sand; common fine tubular pores; medium acid.

The solum is 7 to 15 percent clay. The profile is strongly acid or medium acid.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It is silt loam or fine sandy loam. Some pedons do not have organic stains.

The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. It is silt loam or very fine sandy loam and is 0 to 10 percent coarse fragments.

The 2C horizon has hue of 2.5Y or 5Y. It is loamy fine sand, fine sand, or medium sand.

The 3C horizon has stratified sandy, loamy, and silty sediment.

Larush Variant

The Larush Variant consists of very deep, moderately well drained soils on alluvial fans and stream terraces. These soils formed in mixed alluvium and have an influence of volcanic ash. Slopes are 0 to 3 percent. Elevation is 25 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 160 to 200 days.

These soils are medial over loamy, mixed, mesic Fluvaquentic Xerochrepts.

Typical pedon of Larush Variant silt loam, 0.5 mile southeast of Belfast, 700 feet south and 1,150 feet east of the northwest corner of sec. 5, T. 35 N., R. 4 E.

Ap-0 to 9 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; soft, very friable, slightly sticky and. slightly plastic; common very fine roots; many very fine discontinuous interstitial and tubular pores; 5 percent pebbles and 2 percent cobbles; pH is 10.5 in sodium fluoride; slightly acid; clear wavy boundary.

Bw1-9 to 14 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine discontinuous interstitial and tubular pores; pH is 11.3 in sodium fluoride; slightly acid; clear wavy boundary.

Bw2-14 to 19 inches; light olive brown (2.5Y 5/4) sandy loam, light yellowish brown (2.5Y 6/4) dry; weak medium and coarse platy structure; soft, very friable. slightly sticky and slightly plastic; common very fine roots; many very fine discontinuous interstitial and tubular pores; pH is 11.1 in sodium fluoride. slightly acid; abrupt wavy boundary.

C1-19 to 29 inches; brown (10YR 5/3) silty clay loam, pale brown (10YR 6/3) dry; few fine faint gray (5Y 5/1) mottles; massive; hard, firm, slightly sticky and plastic; few very fine roots; common very fine discontinuous interstitial pores; pH is 9.8 in sodium fluoride; slightly acid; clear wavy boundary.

C2-29 to 36 inches; pale olive (5Y 6/3) sandy clay loam, light gray (2.5Y 7/2) dry; common fine faint gray (5Y 5,1) mottles; massive; hard, firm, sticky and plastic, few very fine roots; common very fine discontinuous interstitial pores; pH is 9.0 in sodium fluoride; slightly acid; gradual wavy boundary.

C3-36 to 43 inches; yellowish brown (10YR 5/4) sandy loam. pale brown (10YR 6/3) dry; common medium distinct gray (5Y 5/1) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine discontinuous interstitial pores; pH is 9.0 in sodium fluoride; slightly acid; clear wavy boundary.

C4-43 to 48 inches;; light olive brown (2.5Y 5/4) heavy loam, light gray (2.5Y 7/2) dry; common medium distinct gray (5Y 5/1) and yellowish red (5YR 5/6) mottles; massive; hard, firm, sticky and plastic; common very fine discontinuous interstitial pores; pH is 9.0 in sodium fluoride; slightly acid; clear wavy boundary.

C5-48 to 60 inches; yellowish brown (10YR 5/4) silty clay loam, light yellowish brown (10YR 6/4) dry; few fine distinct yellowish red (5YR 5/6) mottles; massive; hard, firm, sticky and plastic; few very fine discontinuous interstitial pores; pH is 9.0 in sodium fluoride; slightly acid.

The control section averages 0 to 15 percent coarse fragments. Depth of the influence of volcanic ash ranges from 13 to 28 inches. The profile is medium acid to neutral.

The A horizon has value of 5 or 6 when dry, and it has chroma of 2 to 4 when moist or dry.

The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 4 or 5 when moist or dry.

The C horizon has hue of 5Y, 2.5Y, or 10YR. It is stratified silty clay loam to sandy loam.

Marblemount Series

The Marblemount series consists of moderately deep, well drained soils on glaciated mountainsides. These soils formed in volcanic ash, glacial till, and colluvium derived from granite. Slopes are 65 to 90 percent. Elevation is 800 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 110 to 150 days.

These soils are sandy-skeletal, mixed, frigid Typic Haplorthods.

Typical pedon of a Marblemount very stony sandy loam in an area of Marblemount-Rock outcrop complex, 65 to 90 percent slopes, about 4 miles west of Marblemount, 200 feet north and 1,060 feet east of the southwest corner of sec. 14, T. 33 N., R. 11 E.

Oi-3 inches to 0; needles and twigs.

E-0 to 1 inch; gray (10YR 5/1) very gravelly sandy loam, white (10YR 8/1) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; common very fine irregular pores; 35 percent pebbles; pH is less than 9.4 in sodium fluoride; strongly acid; abrupt smooth boundary.

Bs1-1 inch to 6 inches; dark brown (7.5YR 4/4) very stony sandy loam, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine roots; common very fine irregular pores; 20 percent pebbles, 10 percent cobbles, and 15 percent stones; pH is 11.5 in sodium fluoride;

strongly acid; clear wavy boundary.

Bs2-6 to 17 inches; dark yellowish brown (10YR 4/4) very stony loamy sand, very pale brown (10YR 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine roots; common very fine irregular pores; 20 percent pebbles, 5 percent cobbles. and 20 percent stones; pH is 11.5 in sodium fluoride; strongly acid; abrupt smooth boundary.

C-17 to 24 inches; light yellowish brown (2.5Y 6/4) very stony loamy sand, pale yellow (2.5Y 8/4) dry; weak fine subangular blocky structure; soft, very friable. nonsticky and nonplastic; few very fine roots; common very fine irregular pores; 20 percent pebbles. 5 percent cobbles, and 20 percent stones; pH is 11.5 in sodium fluoride; medium acid; abrupt smooth boundary.

Cr-24 inches; weathered granite.

The depth to weathered granite is 20 to 40 inches. The profile is strongly acid or medium acid.

The E horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 1 or 2 when moist or dry.

The Bs horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist or dry, It is very stony loamy sand, very stony sandy loam, or very gravelly loamy sand.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 when moist and 6 to 8 when dry, and chroma of 4 to 6 when moist or dry. It is very stony loamy sand or very gravelly loamy sand.

Minkler Series

The Minkler series consists of very deep, moderately well drained soils on river terraces that are rarely flooded. These soils formed in alluvial and lacustrine material. Slopes are 0 to 3 percent. Elevation is 50 to 80 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

These soils are medial over loamy, mixed, mesic Aquic Xerochrepts.

Typical pedon of Minkler silt loam, 2 miles east of Sedro Woolley, 3,250 feet west and 1,350 feet south of the northeast corner of sec. 20, T. 35 N.. R. 5 E.

Ap-0 to 12 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 very fine roots; few very fine discontinuous vesicular pores; pH is 11.0 in sodium fluoride; slightly acid; abrupt smooth boundary.

Bw-12 to 15 inches; olive gray (5Y 5/2) silt loam, light gray (5Y 7/2) dry; many medium prominent strong brown (7.5YR 5/6, 5/8) mottles; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine discontinuous vesicular and tubular pores; pH is 10.7 in sodium fluoride; slightly acid; abrupt smooth boundary.

C1-15 to 20 inches; dark gray (5Y 4/1), stratified loamy fine sand and very fine sandy loam, gray and light gray (5Y 6/1, 7/1) dry; many fine distinct yellowish brown (10YR 5/6) mottles; massive; soft, very friable, nonsticky and nonplastic; few very fine discontinuous vesicular pores; pH is 11.0 in sodium fluoride; neutral; abrupt smooth boundary.

2C2-20 to 43 inches; gray (5Y 5/1), stratified loamy fine sand and very fine sandy loam, gray and light gray (5Y 6/1, 7/1) dry; common medium and large yellowish brown (10YR 5/6) mottles; massive; soft, very friable, nonsticky and nonplastic; distinct strata of loamy fine sand and very fine sandy loam 1 to 4 millimeters thick; pH is less than 9.0 in sodium fluoride; neutral; clear smooth boundary.

2C3-43 to 55 inches; gray (5Y 5/1) very fine sandy loam, light gray (5Y 7/1) dry; few medium distinct light olive brown (2.5Y 5/6) mottles; massive; soft, very friable, nonsticky and nonplastic; pH is less than 9.0 in sodium fluoride; neutral; abrupt smooth boundary.

2C4-55 to 60 inches; gray (5Y 5/1) loamy fine sand, light gray and gray (5Y 7/1, 6/1) dry; many large prominent strong brown (7.5YR 5/6) mottles; massive; soft, very friable, nonsticky and nonplastic; neutral.

Thickness of the volcanic ash influence is 14 to 27 inches. The lower part of the control section averages 1 to 10 percent clay. The profile is medium acid to neutral.

The Ap horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist or dry.

The Bw horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 to 4 when moist or dry. It is silt loam, loam, or very fine sandy loam.

The C horizon has hue of 2.5Y or 5Y, value of 4 to 6

when moist and 6 or 7 when dry, and chroma of 0 to 2 when moist or dry. It is stratified loamy fine sand, fine sand, and very fine sandy loam.

Montborne Series

The Montborne series consists of moderately deep, moderately well drained soils on glaciated mountainsides. These soils formed in glacial till and colluvium that has a high content of phyllite and has an admixture of volcanic ash, Slopes are 3 to 65 percent. Elevation is 1,200 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F. and the average frost-free season is 120 to 140 days.

These soils are medial-skeletal, frigid Andic Xerochrepts.

Typical pedon of Montborne very gravelly loam, 30 to 65 percent slopes, about 5 miles north of Lyman, 2,520 feet north and 2.300 feet east of the southwest corner of sec. 17, T. 36 N.. R. 6 E.

Oe-3 inches to 0; partially decomposed wood fragments, twigs, and needles.

A-0 to 2 inches; dark reddish brown (5YR 3/3) gravelly loam, reddish brown (5YR 5/3) dry; weak fine granular structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; 30 percent angular pebbles; pH is less than 9.2 in sodium fluoride; strongly acid; clear smooth boundary.

Bw1-2 to 8 inches; reddish brown (5YR 4/4) extremely gravelly loam, strong brown (7.5YR 5/6) dry; weak fine and medium granular structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common very fine, fine, and medium roots; many very fine irregular pores; 50 percent angular pebbles and 15 percent cobbles; pH is 10.5 in sodium fluoride; strongly acid; gradual irregular boundary.

Bw2-8 to 18 inches; dark brown (7.5YR 4/4) extremely gravelly loam, reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and slightly plastic; weakly smeary; common very fine and fine roots; common very fine and fine irregular pores; 50 percent angular pebbles and 15 percent cobbles; pH is 10.5 in sodium fluoride; medium acid; clear smooth boundary.

2Bw3-18 to 22 inches; dark yellowish brown (10YR 4/4) extremely gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft. very friable, slightly sticky and slightly plastic; common very fine and few fine roots; common fine irregular pores; 45 percent angular pebbles and 20 percent cobbles; pH is 10.5 in sodium fluoride; strongly acid; abrupt smooth boundary.

2C-22 to 32 inches; yellowish brown (10YR 5/4) extremely gravelly loam, olive yellow (2.5Y 6/6) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; very few very fine roots; 45 percent angular pebbles and 20 percent cobbles; pH is 10.5 in sodium fluoride; strongly acid; abrupt smooth boundary.

2Cr-32 to 60 inches; light brownish gray (2.5Y 6/2), dense glacial till that crushes to very gravelly loam, light gray (5Y 7/2) dry; many large distinct dark yellowish brown (10YR 4/6) iron stains, pale yellow (2.5Y 7/4) dry; massive; hard, firm, slightly sticky and slightly plastic; 45 percent angular pebbles; strongly acid.

The depth to dense glacial till is 20 to 40 inches. The profile is medium acid or strongly acid throughout. The control section averages 40 to 70 percent rock fragments.

The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 2 or 3 when moist or dry. It is 15 to 30 percent rock fragments. Some pedons have an E horizon.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, 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 very gravelly loam, very gravelly silt loam, extremely gravelly loam, or extremely gravelly sandy loam.

The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 to 6 when moist or dry. It is extremely gravelly loam, extremely gravelly sandy loam, or very gravelly silt loam.

Mt. Vernon Series

The Mt. Vernon series consists of very deep, moderately well drained soils on flood plains and natural levees. These soils formed in recent alluvium with an admixture of volcanic ash. Slopes are 0 to 3 percent. Elevation is 10 to 50 feet. The average annual precipitation is about 32 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 210 days.

These soils are medial over loamy. mixed, mesic Fluvaquentic Haploxerolls.

Typical pedon of Mt. Vernon very fine sandy loam, about 1 mile south of Allen, 380 feet east and 1,900 feet south of the northwest corner of sec. 24, T. 35 N., R. 3 E.

Ap-0 to 10 inches, dark brown (10YR 3/3) very fine sandy loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine irregular pores; pH is 10.3 in sodium fluoride; neutral; abrupt smooth boundary.

C1-10 to 14 inches; dark yellowish brown (10YR 4/4), stratified fine sandy loam and very fine sandy loam, pale yellow (2.5Y 7/4) dry; common medium dark grayish brown (2.5Y 4/2), olive brown (2.5Y 4/4), and strong brown (7.5Y 4/6) mottles; massive; soft. very friable, nonsticky and nonplastic; common very fine roots; common very fine irregular pores; pH is 11.0 in sodium fluoride; neutral; clear wavy boundary.

C2-14 to 29 inches; grayish brown (2.5Y 5/2), stratified very fine sandy loam, loamy fine sand, and fine sand. light brownish gray (2.5Y 6/2) dry; common medium gray (10YR 6/1) and strong brown (7.5YR 5/6) mottles; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; few very fine irregular pores; strata of very dark brown (10YR 2/2) silt loam 2 centimeters thick; pH is 11.3 in sodium fluoride; neutral; clear wavy boundary.

2C3-29 to 42 inches; grayish brown (2.5Y 5/2), stratified fine sandy loam, loamy fine sand, and silt loam, light brownish gray (2.5 6/2) dry; common medium olive brown (2.5Y 4/4) mottles; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; pH is less than 9.0 in sodium fluoride; neutral; clear wavy boundary.

2C4-42 to 60 inches; olive gray (5Y 4/2), stratified fine sand, loamy fine sand, and very fine sandy loam, light olive gray (5Y 6/2) dry; common medium olive brown (2.5Y 4/4) mottles; massive; soft, very friable, nonsticky and nonplastic; pH is less than 9.0 in sodium fluoride; neutral.

Thickness of the medial material and depth to the 2C horizon are 15 to 30 inches. The profile is medium acid to neutral throughout. Depth to the apparent high water table is 24 to 48 inches in winter and early in spring.

The Ap horizon has hue of 2.5Y or 10YR. value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 to 3 when moist or dry.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry. It is stratified very fine sandy loam, fine sandy loam, loamy fine sand, and fine sand.

The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 or 3 when moist or dry. It is stratified silt loam, very fine sandy loam, fine sandy loam, loamy fine sand, and fine sand.

Mukilteo Series

The Mukilteo series consists of very deep, very poorly drained soils in depressional areas. These soils formed in decayed plant remains. Slopes are 0 to 1 percent. Elevation is 50 to 1,000 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

These soils are dysic, mesic Typic Medihemists.

Typical pedon of Mukilteo muck, about 4 miles north of Sedro Woolley, 340 feet south and 1,400 feet east of the northwest corner of sec. 6, T. 35 N., R. 5 E.

Oa-0 to 5 inches; black (10YR 2/1) muck; about 20 percent fibers, 10 percent rubbed; common very fine roots; extremely acid; abrupt smooth boundary.

Oe1-5 to 12 inches; dark reddish brown (5YR 2/2) hemic material; about 50 percent fibers, 20 percent rubbed; few very fine roots; extremely acid; clear smooth boundary.

Oe2-12 to 28 inches; dark reddish brown (5YR 3/2) sapric material; about 40 percent fibers, 15 percent rubbed; few very fine roots; extremely acid; clear smooth boundary.

Oe3-28 to 48 inches; dark reddish brown (5YR 2/2) hemic material; about 30 percent fibers, 25 percent rubbed; very few very fine roots; extremely acid; clear smooth boundary.

Oe4-48 to 60 inches; black (10YR 2/1) sapric material; about 40 percent fibers, 10 percent rubbed; extremely acid.

The surface tier has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3 when moist, and chroma of 1 or 2. It generally has one or more layers of sapric material that are less than 15 percent rubbed fiber.

The subsurface tiers are mostly hemic material. They have hue of 5YR or 10YR and value and chroma of 2 or 3 when moist. The content of rubbed fiber is 15 to 50 percent, and the content of rock fragments is 0 to 10 percent.

The bottom tier is sapric or hemic material. It has hue of 5YR or 10YR, value of 2 or 3 when moist, and chroma of 1 to 3 when moist. It contains wood in some pedons.

The Mukilteo soils in this survey area have less fiber in the subsurface and bottom tiers than is typical for the Mukilteo series. This difference, however, does not significantly affect use and management of these soils.

Mukilteo Variant

The Mukilteo Variant consists of very deep, poorly drained soils in depressional areas of flood plains. Drainage has been partially altered by use of tile and open ditches. These soils formed in decayed plant remains over fine textured alluvium. Slopes are 0 to 2 percent. Elevation is 10 to 200 feet. The average annual precipitation is about 30 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

These soils are clayey, mixed, euic, mesic Terric Medisaprists.

Typical pedon of Mukilteo Variant muck, about 6 miles north of Burlington, 1,000 feet west and 50 feet south of the northeast corner of sec. 5, T. 35 N., R. 5 E.

Oa1-0 to 9 inches; black (5YR 2/1) muck; about 25 percent fibers, 15 percent rubbed; many very fine and fine roots and common medium and coarse roots; slightly acid; clear irregular boundary.

Oa2-9 to 17 inches; black (5YR 2/1) sapric material; about 20 percent fibers, 10 percent rubbed; a layer of volcanic ash 0.5 inch thick is along the lower part of this horizon; common very fine, fine, medium, and coarse roots,, slightly acid; abrupt smooth boundary.

Oa3-17 to 22 inches; black (5YR 2/1) sapric material; about 20 percent fibers, 10 percent rubbed; few very fine roots; slightly acid; clear smooth boundary.

2C-22 to 60 inches; greenish gray (5GY 6/1) silty clay, light gray (5Y 7/1) dry; massive; hard, firm, sticky and plastic; medium acid; few very fine roots.

These soils are partially artificially drained; however, the water table normally is at or near the surface in winter. Depth to the mineral layer is 16 to 50 inches.

The surface tier has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3 when moist, and chroma of 1 or 2.

The subsurface tiers are sapric material. They have hue of 5YR, 7.5YR, or 10YR, value of 2 or 3 when moist, and chroma of 1 or 2.

The 2C horizon is silty clay or clay. It has hue of 5Y or 5GY.

Mundt Series

The Mundt series consists of very deep, moderately well drained soils on dissected canyonsides and terrace escarpments. These soils formed in glaciolacustrine sediment. Slopes are 45 to 75 percent. Elevation is 400 to 1,100 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 47 degrees F, and the average frost-free season is 160 to 180 days.

These soils are fine-silty, mixed, mesic Aquic Dystric Eutrochrepts.

Typical pedon of Mundt silt loam, 45 to 75 percent slopes, about 8 miles northeast of Concrete, about 1,300 feet south and 2,510 feet west of the northeast corner of sec. 1, T. 36 N., R. 8 E.

Oi-0.5 inch to 0; leaves and twigs.

A-0 to 2 inches; dark brown (10YR 3/3) silt loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine irregular pores; medium acid; abrupt wavy boundary.

AB-2 to 6 inches; olive (5Y 5/3) silt loam, light gray (2.5Y 7/2) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine irregular pores; medium acid; gradual wavy boundary.

Bw-6 to 32 inches; olive (5Y 5/3) silt loam, white (2.5Y 8/2) dry; few fine distinct brownish yellow (10YR 6/6) mottles; weak fine subangular blocky structure; slightly hard, friable, sticky and plastic; few fine roots; common very fine irregular pores; medium acid; gradual wavy boundary.

C-32 to 60 inches; olive (5Y 5/3) silt loam, pale yellow (5Y 7/3) dry; common fine distinct reddish yellow (7.5YR 6/6) mottles; massive; slightly hard, friable, sticky and plastic; few very fine roots; common very fine irregular pores; medium acid.

The control section averages 18 to 32 percent clay and 0 to 5 percent rock fragments.

The A and AB horizons have hue of 10YR, 2.5Y, or

5Y, value of 3 to 5 when moist and 5 to 8 when dry, and chroma of 1 to 3 when moist or dry.

The Bw and C horizons have hue of 2.5Y or 5Y, value of 5 or 6 when moist and 7 or 8 when dry, and chroma of 2 or 3 when moist or dry. They are mainly silt loam or silty clay loam, but some pedons have lenses of very fine sand. These horizons are strongly acid or medium acid.

Nargar Series

The Nargar series consists of very deep, well drained soils on terraces. These soils formed in loess and volcanic ash underlain by sandy alluvium. Slopes are 0 to 8 percent. Elevation is 50 to 900 feet. The average annual precipitation is about 65 inches. the average annual air temperature is about 51 degrees F. and the average frost-free season is 160 to 200 days.

These soils are medial over sandy or sandy-skeletal, mixed. mesic Andic Xerochrepts.

Typical pedon of Nargar loam. 0 to 8 percent slopes, about 3 miles southwest of Concrete, 2,000 feet north and 300 feet east of the southwest corner of sec. 24, T. 35 N.. R. 8 E.

Oi-6 inches to 0; needles, twigs. and wood fragments.
A-0 to 3 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 5/4) dry; weak fine granular structure; soft. very friable, nonsticky and slightly plastic; common very fine roots; common very fine irregular pores; 5 percent rounded pebbles; pH is 10.2 in sodium fluoride; strongly acid; clear wavy boundary.
Bw1-3 to 8 inches; strong brown (7.5YR 4/6) loam, reddish yellow (7.5YR 6/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common very fine roots; common very fine irregular pores; 5 percent rounded pebbles; pH is 12.0 in sodium fluoride; strongly acid; clear wavy boundary.
Bw2-8 to 22 inches; dark yellowish brown (10YR 4/6) loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; weakly smeary; few very fine roots; common very fine irregular pores; 5 percent rounded pebbles; pH is 12.0 in sodium fluoride; strongly acid; clear wavy boundary.
Bw3-22 to 33 inches; strong brown (7.5YR 5/6) loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; weakly smeary; common coarse roots; common very fine irregular pores; 5 percent rounded pebbles; pH is 12.0 in sodium fluoride; medium acid; abrupt wavy boundary.
2C-33 to 60 inches; light olive brown (2.5Y 5/4) sand, light gray (5Y 7/1) dry; single grain; loose; few medium roots; common fine irregular pores; 15 percent rounded pebbles; pH is 12.0 in sodium fluoride; medium acid.

The solum is 15 to 35 inches thick. The upper part of the control section averages 0 to 15 percent coarse fragments. The profile is strongly acid or medium acid.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. Some pedons have an E horizon.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is loam or silt loam. Some pedons have a BC horizon that is sandy loam.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 1 to 4 when moist or dry. It dominantly is loamy sand or sand, but it has strata of gravel in some pedons.

Nookachamps Series

The Nookachamps series consists of very deep, poorly drained soils on flood plains. Drainage has been altered by tiling. These soils formed in alluvium. Slopes are 0 to 2 percent. Elevation is 45 to 250 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

These soils are fine-silty, mixed, nonacid. mesic Typic Fluvaquents.

Typical pedon of Nookachamps silt loam, 1.5 miles southeast of Clear Lake, 3,350 feet north of the southwest corner of sec. 18, T. 34 N., R. 5 E.

Ap-0 to 9 inches; olive brown (2.5Y 4/4) silt loam, light yellowish brown (10YR 6/4) dry; common fine faint gray (5Y 5/1) mottles and common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine, fine, medium, and coarse roots; common very fine irregular pores; slightly acid; abrupt smooth boundary.
Bg1-9 to 26 inches;, gray (2.5Y 6/0) silt loam, light gray (5Y 7/1) dry; many medium distinct yellowish brown

(10YR 5/8) mottles; moderate very coarse subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; common very fine irregular pores; neutral; gradual smooth boundary,

Bg2-26 to 32 inches; gray (5Y 5/1) silt loam, light gray (N 7/0) dry; many moderate distinct strong brown (7.5YR 5/8) mottles; moderate coarse prismatic structure; hard, friable, sticky and plastic; few very fine roots; common very fine irregular pores; neutral; abrupt smooth boundary.

Cg-32 to 60 inches; gray (N 6/0) silt loam, light gray (N 7/0) dry; common medium distinct yellowish brown (10YR 5/8) mottles around tubular pores; massive; hard. friable, sticky and plastic; few very fine roots; many medium continuous vertical tubular pores; 0.25-inch-thick strata of organic material at a depth of 32 inches; pink mottles in lower part; neutral.

The solum is 24 to 40 inches thick. The control section is 18 to 35 percent clay and less than 15 percent fine sand or coarser. Depth to the apparent high water table is 6 to 18 inches during November to March.

The A horizon has hue of 2.5Y or 10YR, value of 5 to 7 when dry, and chroma of 1 to 4 when moist or dry. It is medium acid or slightly acid.

The Bg horizon has hue of 2.5Y or 5Y or is neutral. It has value of 4 to 7 when moist or dry and chroma of 0 to 2 when moist or dry. It is silt loam or silty clay loam and is slightly acid or neutral.

The Cg horizon has hue of 5Y or is neutral. It has value of 5 to 7 when moist or dry and chroma of 0 or 1 when moist or dry. It is silt loam or silty clay loam. Some pedons do not have thin strata of organic material. The horizon is slightly acid or neutral.

Norma Series

The Norma series consists of very deep, poorly drained soils in drainageways and depressional areas. These soils formed in alluvium. Slopes are 0 to 3 percent. Elevation is 50 to 1,000 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 200 days.

These soils are coarse-loamy, mixed, nonacid, mesic Mollic Haplaquepts.

Typical pedon of Norma silt loam, about 3 miles southeast of Conway, 2,100 feet north and 2,300 feet west of the southeast corner of sec. 27, T. 33 N., R. 4 E.

A-0 to 6 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; common very fine irregular pores; 10 percent rounded pebbles; slightly acid; abrupt smooth boundary.

AB-6 to 11 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; common large distinct yellowish brown (10YR 5/8) mottles; weak medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; common very fine irregular pores; 10 percent rounded pebbles; slightly acid; clear smooth boundary.

Bg1-11 to 23 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; many large distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; common very fine irregular pores; 10 percent rounded pebbles; slightly acid; gradual wavy boundary.

Bg2-23 to 45 inches; dark grayish brown (2.5Y 4!2) gravelly sandy loam, light brownish gray (2.5Y 6/2) dry; many medium distinct brownish yellow (10YR 6/8) mottles; massive; slightly hard, very friable, nonsticky and slightly plastic; few very fine roots; common very fine irregular pores; 15 percent rounded pebbles; medium acid; clear smooth boundary.

Cg1-45 to 53 inches; dark grayish brown (2.5Y 4/2) very gravelly sandy loam, light brownish gray (2.5Y 6/2) dry; many medium distinct brownish yellow (10YR 6/8) mottles; massive; soft, very friable, nonsticky and nonplastic; common very fine irregular pores; 35 percent rounded pebbles; slightly acid; abrupt smooth boundary.

Cg2-53 to 60 inches; very dark grayish brown (2.5Y 3/2) very gravelly sandy loam, grayish brown (2.5Y 5/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine irregular pores; 50 percent rounded pebbles; slightly acid.

The control section averages 10 to 20 percent coarse fragments, less than 18 percent clay, and more than 15 percent sand that is fine or coarser. The profile is medium acid or slightly acid.

The A and AB horizons have value of 2 or 3 when moist and 4 or 5 when dry, and they have chroma of 1 or 2 when moist or dry.

The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist and 5 or 6 when dry, and chroma

of 2 or 3 when moist or dry. It is loam, sandy loam, gravelly loam, or gravelly sandy loam.

The Cg horizon has variegated colors and is sandy loam, loamy sand, gravelly sandy loam, gravelly loamy sand, very gravelly sandy loam, or very gravelly loamy sand.

Oakes Series

The Oakes series consists of deep, well drained soils on glacially modified mountainsides. These soils formed in colluvium derived from andesite and argillite containing glacial till and volcanic ash. Slopes are 30 to 65 percent. Elevation is 1,000 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 140 days.

These soils are medial-skeletal, frigid Andic Xerochrepts.

Typical pedon of Oakes gravelly silt loam, 30 to 65 percent slopes, about 3 miles northwest of Cavanaugh Lake, 2,400 feet south and 120 feet east of the northwest corner of sec. 9. T. 33 N., R. 6 E.

Oi-2 inches to 0; undecomposed needles, leaves, and twigs.

A-0 to 3 inches; dark brown (10YR 3/3) gravelly silt loam, light yellowish brown (10YR 6/4) dry; moderate fine granular structure; soft, very friable, slightly sticky and nonplastic; few very fine and fine roots; many fine irregular pores; 15 percent angular pebbles and 5 percent cobbles; pH is less than 9.4 in sodium fluoride; medium acid; abrupt smooth boundary.

Bw1-3 to 17 inches; dark brown (7.5YR 4/4) very gravelly loam, brownish yellow (10YR 6/6) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and slightly plastic; weakly smeary; common very fine and fine roots and few medium roots; common very fine irregular pores; 40 percent angular pebbles and 10 percent cobbles; pH is 10.5 in sodium fluoride; medium acid; clear smooth boundary.

Bw2-17 to 34 inches; yellowish brown (10YR 5/4) very gravelly loam, very pale brown (10YR 7/4) dry; weak fine subangular blocky structure parting to weak medium granular; slightly hard, friable, slightly sticky and slightly plastic; few medium and coarse roots; common fine irregular pores; 35 percent angular pebbles and 10 percent cobbles; pH is 10.5 in sodium fluoride; medium acid; clear smooth boundary.

Bw3-34 to 42 inches; dark yellowish brown (10YR 4/4) very gravelly loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; few fine and medium roots; common fine irregular pores; 35 percent pebbles and 10 percent cobbles; pH is 10.0 in sodium fluoride; medium acid; clear smooth boundary.

C-42 to 50 inches; olive brown (2.5Y 4/4) very gravelly loam, pale yellow (5Y 7/4) dry; massive; soft, friable, nonsticky and slightly plastic; common very fine and few fine roots; few very fine irregular pores; 40 percent rounded pebbles and 15 percent cobbles; medium acid; abrupt smooth boundary.

R-50 inches; argillite.

The depth to bedrock ranges from 40 to 60 inches. The profile is strongly acid or medium acid throughout. The control section is 35 to 70 percent rock fragments.

The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 3 or 4 when moist or dry. The A horizon may be absent in some pedons.

The Bw horizon has hue of 5YR, 7.5YR, 10YR, or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist or dry. It is very gravelly loam, very gravelly sandy loam, or extremely gravelly sandy loam.

The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. It is very gravelly loam, very gravelly sandy loam, or extremely gravelly sandy loam.

Pilchuck Series

The Pilchuck series consists of very deep, excessively drained soils on flood plains. These soils formed in alluvium. Slopes are 0 to 3 percent. Elevation is 20 to 500 feet. The average annual precipitation is about 55 inches. the average annual air temperature is about 52 degrees F, and the average frost-free season is 160 to 210 days.

These soils are mixed, mesic Dystric Xeropsamments.

Typical pedon of Pilchuck loamy sand, about 1 mile south of Rockport, 2,900 feet west and 700 feet south of the northeast corner of sec. 1 , T. 34 N., R. 9 E.

A-0 to 3 inches; dark grayish brown (2.5Y 4/2) loamy sand, grayish brown (2.5Y 5/2) dry; single grain; loose; many fine roots; many very fine irregular pores; medium acid; clear smooth boundary.

C1-3 to 22 inches; dark grayish brown (2.5Y 4/2) fine sand, grayish brown (2.5Y 5/2) dry; single grain; loose; many fine roots; many very fine irregular pores; medium acid; clear smooth boundary.
C2-22 to 43 inches; dark grayish brown (2,5Y 4/2) sand, grayish brown (2.5Y 5/2) dry; single grain; loose; many fine irregular pores; medium acid; 10 percent rounded pebbles; clear smooth boundary.
C3-43 to 60 inches; very dark grayish brown (2.5Y 3/2) gravelly sand, dark grayish brown (2.5Y 4/2) dry; single grain; loose; 25 percent rounded pebbles; medium acid.

The control section averages 0 to 15 percent coarse fragments. In some pedons strata of fine sandy loam are in the control section, and in some pedons the lower part of the control section is stratified sand and gravel. The profile is medium acid to neutral.

The C1 and C2 horizons have hue of 2.5Y or 10YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 1 or 2 when moist or dry. They are loamy fine sand, fine sand, or sand.

The Cg horizon has color similar to that of the C1 and C2 horizons. It is gravelly fine sand or gravelly sand.

Pilchuck Variant

The Pilchuck Variant consists of very deep, moderately well drained soils on terraces and levees. These soils formed in alluvium. Slopes are 0 to 3 percent. Elevation is 10 to 50 feet. The average annual precipitation is about 30 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 170 to 220 days.

These soils are mixed, mesic Aquic Xeropsammments.

Typical pedon of Pilchuck Variant fine sandy loam, about 1 mile northeast of Allen, 1,250 feet south and 100 feet east of the northwest corner of sec. 19, T. 35 N., R. 4 E.

Ap-0 to 8 inches; dark brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; moderate coarse subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine and fine roots; few very fine irregular pores; slightly acid; abrupt wavy boundary.
C1-8 to 13 inches; grayish brown (2.5Y 5/2), stratified loamy fine sand and fine sand and 1-inch-thick strata of very fine sandy loam, light gray and light brownish gray (2.5Y 7/2, 6/2) dry; common large prominent strong brown (7.5YR 5/6) mottles; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; few very fine irregular and tubular pores; neutral; clear wavy boundary.
C2-13 to 32 inches; dark gray (5Y 4/1), stratified loamy fine sand and fine sand and 1-inch-thick strata of very fine sandy loam, gray (5Y 6/1) dry; common large prominent strong brown (7.5YR 5/6) mottles; massive; loose; few very fine roots; few very fine tubular and irregular pores; neutral; gradual wavy boundary.
C3-32 to 60 inches; gray (5Y 5/1) fine sand, light gray (5Y 7/1) dry; few very fine grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) mottles; single grain; loose; few very fine tubular pores; neutral.

The control section is mainly loamy fine sand or coarser, but it has lenses of very fine sandy loam or silt loam as much as 2 inches thick.

The A 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.

The C horizon, to a depth of 40 inches, has value of 4 to 6 when moist and 5 to 7 when dry, and it has chroma of 0 to 2 when moist or dry. The C horizon, below a depth of 40 inches, has hue of 5Y or 2.5Y, and it has chroma of 0 to 2 when moist or dry. The C horizon is loamy fine sand, fine sand, or sand.

Rinker Series

The Rinker series consists of moderately deep, well drained soils on glacially modified mountainsides. These soils formed in colluvium derived from volcanic ash, glacial till, and phyllite. Slopes are 30 to 65 percent. Elevation is 1,000 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 150 days.

These soils are medial-skeletal, frigid Andic Xerochrepts.

Typical pedon of Rinker very channery loam, 30 to 65 percent slopes, about 6 miles south of Concrete, 2,200 feet south and 800 feet east of the northwest corner of sec. 6, T. 34 N., R. 9 E.

Oi-5 inches to 1 inch; undecomposed needles, twigs, and roots.
Oa-1 inch to 0; decomposed forest litter.
E-0 to 2 inches; pinkish gray (7.5YR 6/2) channery silt loam, light gray (10YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common *very* fine tubular pores; 30

percent channery fragments; pH is less than 9.0 in sodium fluoride; very strongly acid; abrupt smooth boundary.

Bw1-2 to 7 inches; dark brown (7.5YR 4/4) very channery loam, light yellowish brown (10YR 6/4) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common medium roots; common fine irregular pores; 60 percent channery fragments; pH is less than 10.0 in sodium fluoride; very strongly acid; clear wavy boundary.

Bw2-7 to 18 inches; dark yellowish brown (10YR 4/4) very channery loam, light yellowish brown (10YR 6/4) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common fine roots; common fine irregular pores; 50 percent channery fragments and 10 percent flagstones; pH is 10.0 in sodium fluoride; strongly acid; abrupt wavy boundary.

2C-18 to 29 inches; light yellowish brown (2.5Y 6/4) extremely channery silt loam, pale yellow (2.5Y 7/4) dry; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; few fine roots; few fine irregular pores; 55 percent channery fragments and 10 percent flagstones; pH is 9.2 in sodium fluoride; very strongly acid; abrupt wavy boundary.

2R-29 inches; phyllite.

Depth to phyllite is 20 to 40 inches. The control section is 8 to 15 percent clay. The profile is very strongly acid or strongly acid throughout. Depth of the influence of volcanic ash ranges from 12 to 18 inches.

The E horizon has hue of 7.5YR or 10YR, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 2 or 3 when moist or dry. Some pedons do not have an E horizon,

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist or dry. It is very channery silt loam or very channery loam.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 3 to 6 when moist or dry. It is extremely channery silt loam or extremely channery loam.

Saar Series

The Saar series consists of moderately deep, moderately well drained soils on glacially modified mountainsides. These soils formed in volcanic ash, colluvium, and glacial till. Slopes are 3 to 65 percent.

Elevation is 3,100 to 4,500 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 39 degrees F, and the average frost-free season is 90 to 110 days.

These soils are medial-skeletal Humic Cryorthods.

Typical pedon of Saar gravelly silt loam, 30 to 65 percent slopes, about 4 miles northwest of Concrete, 750 feet south and 100 feet west of the northeast corner of sec. 19, T. 36 N., R. 8 E.

Oe-4 inches to 1 inch; partially decomposed branches and needles.

Oa-1 inch to 0; decomposed forest litter.

E-0 to 2 inches; dark brown (7.5YR 4/2) silt loam, pinkish gray (7.5YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; few very fine irregular pores; 10 percent angular pebbles; pH is less than 9.2 in sodium fluoride; strongly acid; abrupt wavy boundary.

Bhs-2 to 12 inches; reddish brown (5YR 4/4) gravelly silt loam, strong brown (7.5YR 5/6) dry; dark reddish brown (5YR 3/2) organic coatings on faces of peds; weak medium subangular blocky structure and weak granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; few fine irregular pores; 20 percent angular pebbles; pH is 9.6 in sodium fluoride; very strongly acid; abrupt irregular boundary.

Bs-12 to 18 inches; strong brown (7/5YR 4/6) very gravelly silt loam, brownish yellow (10YR 6/6) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; common fine and medium irregular pores; 60 percent angular pebbles; pH is 12.0 in sodium fluoride; very strongly acid; clear irregular boundary.

BC-18 to 26 inches; yellowish brown (10YR 5/4) very gravelly loam, pale yellow (2.5Y 7/4) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common fine irregular pores; 65 percent angular pebbles; pH is 11.5 in sodium fluoride; very strongly acid; abrupt wavy boundary.

2Cr-26 to 60 inches; light olive brown (2.5Y 5/4), dense glacial till that crushes to extremely gravelly loam, pale yellow (2.5Y 7/4) dry; massive; very hard, firm, slightly sticky and slightly plastic; 70 percent angular pebbles; pH is 11.0 in sodium fluoride; strongly acid.

Depth to the dense glacial till is 20 to 40 inches. The profile is very strongly acid or strongly acid.

The E horizon has hue of 10YR or 7.5YR, value of 3 to 6 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist or dry.

The matrix of the Bhs horizon has hue of 5YR or 7.5YR, value of 3 to 5 when moist and 4 or 5 when dry. and chroma of 2 to 6 when moist or dry. The organic stains have hue of 2.5YR or 5YR, value of 2 or 3, and chroma of 1 or 2. This horizon is gravelly silt loam or gravelly loam.

The Bs and BC horizons have hue of 7.5YR, 10YR, or 2.5Y, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist or dry. They are very gravelly silt loam, very gravelly loam, or extremely gravelly loam.

The 2Cr horizon is dense glacial till that crushes to extremely gravelly loam or extremely gravelly sandy loam. The horizon has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist or dry. Some pedons have a C horizon overlying the dense till.

Saar Variant

The Saar Variant consists of very deep,, well drained soils on glacially modified mountainsides. These soils formed in volcanic ash and glacial till influenced by granite. Slopes are 30 to 65 percent. Elevation is 2,200 to 4,000 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 38 degrees F, and the average frost-free season is 85 to 110 days.

These soils are medial-skeletal Humic Cryorthods.

Typical pedon of Saar Variant very stony loamy sand, 30 to 65 percent slopes, about 6 miles southeast of Marblemount, 1,360 feet south and 400 feet west of the northeast corner of sec. 35, T. 35 N., R. 11 E.

Oi-1 1 to 5 inches; undecomposed forest litter.

Oa-5 inches to 0; decomposed forest litter.

E-0 to 4 inches; brown (7.5YR 5/2) very stony loamy sand, light gray (10YR 7/1) dry; massive; soft, very friable, nonsticky and nonplastic; common fine roots; common very fine irregular pores; 20 percent rounded pebbles, 10 percent cobbles, and 10 percent stones; pH is less than 9.2 in sodium fluoride; strongly acid; abrupt smooth boundary.

Bhs-4 to 12 inches; dark reddish brown (5YR 3/4) very stony silt loam, reddish yellow (7.5YR 6/6) dry; many coarse dark reddish brown (5YR 2/2) organic stains on faces of peds; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common medium roots; common very fine irregular pores; 15 percent rounded pebbles, 10 percent cobbles, and 15 percent stones; pH is 11.5 in sodium fluoride; strongly acid; clear smooth boundary.

Bs1-12 to 20 inches; strong brown (7.5YR 5/6) very stony sandy loam, reddish yellow (7.5YR 6/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few medium roots; common very fine irregular pores; 15 percent rounded pebbles, 10 percent cobbles, and 15 percent stones; pH is 11.5 in sodium fluoride; strongly acid; clear smooth boundary.

Bs2-20 to 24 inches; dark yellowish brown (10YR 4/6) very stony sandy loam, brownish yellow (10YR 6/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few medium roots; common very fine irregular pores:, 20 percent rounded pebbles, 10 percent cobbles, and 30 percent stones; pH is 11.5 in sodium fluoride; strongly acid; clear smooth boundary.

2BC-24 to 36 inches; olive brown (2.5Y 4/4) very stony sandy loam, light yellowish brown (2.5Y 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few medium roots; common very fine irregular pores; 20 percent rounded pebbles, 10 percent cobbles, and 30 percent stones; pH is 11.5 in sodium fluoride; strongly acid; clear smooth boundary.

2C-36 to 60 inches; light olive brown (2.5Y 5/4), weakly compacted glacial till that crushes to very stony loamy sand, pale yellow (5Y 7/3) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine irregular pores; 20 percent rounded pebbles, 10 percent cobbles, and 30 percent stones; pH is 11.0 in sodium fluoride; strongly acid.

Depth to weakly compacted glacial till is 20 to 40 inches. The control section is 40 to 75 percent rock fragments. The profile is very strongly acid or strongly acid throughout.

The E horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 1 or 2 when moist or dry.

The matrix of the Bhs horizon has hue of 5YR or 7.5YR, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. The organic stains have hue of 2.5YR or 5YR, value of 2 to 4, and

chroma of 2 or 3. The horizon is very stony sandy loam or very stony silt loam.

The Bs horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. It is very stony sandy loam or very stony silt loam.

The 2BC horizon has color and texture similar to that of the 2C horizon.

The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 3 or 4 when moist or dry. It is very stony loamy sand or very stony sandy loam.

Samish Series

The Samish series consists of very deep, somewhat poorly drained soils on stream terraces. Drainage has been partially altered by use of tile and open ditches. These soils formed in alluvium that is high in content of talc and is underlain by old alluvium. Slopes are 0 to 3 percent. Elevation is 45 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 160 to 200 days.

These soils are coarse-silty, mixed, nonacid, mesic Typic Fluvaquents.

Typical pedon of Samish silt loam, about 5 miles north of Sedro Woolley, 2,600 feet west and 200 feet south of the northeast corner of sec. 35, T. 36 N., R. 4 E.

Ap-0 to 8 inches; dark gray (N 4/0) silt loam, gray (N 5/0) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine discontinuous pores; medium acid; abrupt smooth boundary.

Cg1-8 to 23 inches; gray (N 5/0) silt loam, light gray (N 7/0) dry; common large distinct yellowish brown (10YR 5/6, 5/8) mottles; massive; hard, firm, slightly sticky and plastic; common very fine roots; common very fine discontinuous pores; few fine (1 millimeter thick) strata of relict wood and plant remains; discontinuous strata (3 centimeters thick) that have pressure faces observable when broken; soil material feels greasy; slightly acid; abrupt smooth boundary.

2Cg2-23 to 26 inches; dark gray (N 4/0) very fine sandy loam, gray (N 6/0) dry; many large distinct yellowish brown (10YR 5/6, 5/8) mottles; massive; soft. friable, slightly sticky and slightly plastic; common very fine roots; common very fine discontinuous pores; fine (2 to 5 millimeters thick) strata of loamy fine sand, silt loam, and silty clay loam; slightly acid; clear smooth boundary.

2Cg3-26 to 36 inches; dark gray (N 4/0) very fine sandy loam, gray (N 6/0) dry; common large distinct yellowish brown (10YR 5/6), dark grayish brown (2.5Y 4/2), and olive brown (2.5Y 4/2, 4/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine discontinuous pores; fine (2 to 5 millimeters thick) strata of loamy fine sand, silt loam, and silty clay loam; few fine relict wood and plant remains; slightly acid; clear smooth boundary.

2Cg4-36 to 60 inches; greenish gray (5GY 5/1) silt loam, gray (N 6/0) dry; common medium prominent yellowish brown (10YR 5/6) mottles; massive; hard, firm, slightly sticky and plastic; few very fine roots; few very fine pores; slightly acid.

The upper 10 to 20 inches of the control section is more than 40 percent talc. The control section averages less than 15 percent fine sand or coarser and 5 to 18 percent clay. The profile is medium acid or slightly acid throughout.

The A horizon has hue of 10YR or 2.5Y or is neutral. It has value of 4 or 5 when moist or dry and chroma of 0 or 1 when moist or dry,

The Cg and 2Cg horizons have hue of 2.5Y, 5Y, or 5GY or are neutral. They have value of 4 to 7 when moist or dry and chroma of 0 or 1 when moist or dry. Most pedons have yellowish brown mottles in the Cg and 2Cg horizons. The 2Cg horizon is mainly stratified very fine sandy loam and silt loam, but some pedons have very thin strata of loamy fine sand and silty clay loam.

Sandun Series

The Sandun series consists of very deep, well drained soils on mountain foot slopes. These soils formed in loess, volcanic ash, and glacial till derived from dunite. Slopes are 30 to 65 percent. Elevation is 1,200 to 2,200 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 90 to 140 days.

These soils are sandy-skeletal, serpentinitic frigid Andic Xerochrepts.

Typical pedon of Sandun very gravelly sandy loam, 30 to 65 percent slopes, about 6 miles northeast of Hamilton, 1,750 feet south and 1,240 feet east of the northwest corner of sec. 16, T. 36 N., R. 7 E.

Oi-5 inches to 0; undecomposed forest litter.

Bw1-0 to 4 inches; dark brown (7.5YR 3/4) very gravelly sandy loam, light brown (7.5YR 6/4) dry; weak medium granular structure; soft. very friable. nonsticky and nonplastic:- common fine roots; common fine irregular pores; 45 percent rounded pebbles; strongly acid; clear smooth boundary.

Bw2-4 to 9 inches; strong brown (7.5YR 5/6) very cobbly sandy loam, reddish yellow (7.5YR 6/6) dry; weak medium granular structure; soft, very friable, nonsticky and nonplastic; few medium roots; common fine irregular pores; 20 percent rounded pebbles and 20 percent cobbles; strongly acid; clear smooth boundary.

BC-9 to 20 inches; light olive brown (2.5Y 5/6) very cobbly sandy loam, pale yellow (2.5Y 7/4) dry; weak medium granular structure; soft, very friable, nonsticky and nonplastic; very few very fine roots; 30 percent rounded pebbles and 20 percent cobbles; strongly acid; gradual smooth boundary.

C1-20 to 34 inches; yellowish brown (10YR 5/6) very cobbly coarse sandy loam, brownish yellow (10YR 6/6) dry; weak medium granular structure; loose; common medium irregular pores; 30 percent rounded pebbles and 20 percent cobbles; strongly acid; gradual smooth boundary.

C2-34 to 60 inches; light olive brown (2.5Y 5/4) very gravelly sand, pale yellow (2.5Y 7/4) dry; single grain; loose; 35 percent rounded pebbles and 20 percent cobbles; strongly acid.

Thickness of the solum ranges from 20 to 36 inches. The control section averages 40 to 80 percent rock fragments that are dominantly dunite.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 3 to 6 when moist and 4 to 6 when dry. It is 35 to 55 percent pebbles and 5 to 20 percent cobbles. The lower part of the horizon is very gravelly sandy loam or very cobbly sandy loam. The horizon is strongly acid or medium acid.

The BC and C horizons have hue of 10YR or 2.5Y, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 3 to 6 when moist or dry. They are very gravelly sandy loam, very gravelly loamy sand, very gravelly sand, extremely gravelly loamy sand, extremely gravelly sand, very cobbly sandy loam, very cobbly coarse sandy loam, very cobbly loamy sand, or very cobbly sand and are 30 to 65 percent pebbles and 5 to 25 percent cobbles. The horizons are strongly acid to slightly acid.

Sauk Series

The Sauk series consists of very deep, well drained soils on alluvial terraces. These soils formed in alluvium containing volcanic ash. Slopes are 0 to 3 percent. Elevation is 200 to 500 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 52 degrees F, and the average frost-free season is 150 to 190 days.

These soils are medial. mesic Andic Dystrochrepts.

Typical pedon of Sauk silt loam, about 2 miles southwest of Marblemount, 1,500 feet north and 1,800 feet east of the southwest corner of sec. 13, T. 35 N., R. 10 E.

Oi-4 inches to 1 inch; leaves, conifer needles, and twigs.

Oa-1 inch to 0; decomposed needles, leaves, and twigs.

Bw1-0 to 3 inches; dark brown (7.5YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common fine roots; many very fine pores; pH is 10.5 in sodium fluoride; strongly acid; clear smooth boundary.

Bw2-3 to 9 inches; yellowish brown (10YR 5/6) silt loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common fine roots; many very fine pores; pH is 11.0 in sodium fluoride; medium acid; gradual smooth boundary.

Bw3-9 to 18 inches; yellowish brown (10YR 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common fine roots; many very fine pores; pH is 11.0 in sodium fluoride; medium acid; clear smooth boundary.

C-18 to 60 inches; olive brown (2.5Y 4/4) silt loam, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few fine roots; many very fine pores; pH is 11.0 in sodium fluoride; medium acid.

The profile averages 0 to 10 percent rock fragments. Thickness of the volcanic ash influence is 16 to 40 inches.

The Bw horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and

chroma of 4 to 6 when moist or dry. It is silt loam or very fine sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist or dry. It is silt loam or very fine sandy loam.

Saxon Series

The Saxon series consists of very deep, moderately well drained soils on terraces and terrace escarpments. These soils formed in volcanic ash underlain by glaciolacustrine sediment. Slopes are 0 to 30 percent. Elevation is 800 to 2,000 feet. The average annual precipitation is about 70 inches. the average annual air temperature is about 43 degrees F, and the average frost-free season is 100 to 120 days.

These soils are medial, frigid Typic Haplorthods.

Typical pedon of Saxon silt loam, 0 to 30 percent slopes, about 7 miles northeast of Cavanaugh Lake, 1,500 feet south and 2,200 feet west of the northeast corner of sec. 27, T. 34 N., R. 7 E.

Oi-9 to 4 inches; branches, twigs, and needles.

Oa-4 inches to 0; decomposed forest litter.

E-0 to 3 inches; pinkish gray (7.5YR 6/2) silt loam. white (N 8/0) dry; massive; slightly hard, very friable, nonsticky and nonplastic; very few very fine roots; few very fine irregular pores; 5 percent rounded pebbles; pH is less than 9.4 in sodium fluoride; very strongly acid; abrupt wavy boundary.

Bhs-3 to 6 inches; yellowish red (5YR 4/6) silt loam, strong brown (7.5YR 5/6) dry; many coarse dark reddish brown (5YR 3/2) organic stains on faces of peds; weak coarse subangular blocky structure; hard, firm, slightly sticky and nonplastic; weakly smeary; few medium and coarse roots; common fine irregular pores; 5 percent rounded pebbles; pH is 12,0 in sodium fluoride; strongly acid; abrupt wavy boundary.

Bs-6 to 9 inches; strong brown (7.5YR 5/6) silt loam, very pale brown (10YR 7/4) dry; few coarse dark reddish brown (5YR 3/2) organic stains on faces of peds; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine roots; common very fine irregular pores; 5 percent rounded pebbles; pH is 12.0 in sodium fluoride; strongly acid; abrupt wavy boundary.

2C1-9 to 21 inches; light yellowish brown (2.5Y 6/4) silt loam, pale yellow (2.5Y 8/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; very few very fine roots; very few very fine irregular pores; pH is 11.5 in sodium fluoride; strongly acid; clear wavy boundary.

2C2-21 to 38 inches; light gray (5Y 7/1) silty clay loam. white (5Y 8/1) dry, common fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm, slightly sticky and plastic; very few very fine tubular pores; pH is 10.0 in sodium fluoride; strongly acid; gradual wavy boundary.

2C3-38 to 60 inches; light olive gray (5Y 6/2) silty clay loam, white (5Y 8/1) dry; few fine distinct brownish yellow (10YR 6/6) mottles; massive; hard, firm, sticky and plastic; pH is 9.8 in sodium fluoride; strongly acid.

The control section averages 18 to 30 percent clay. The profile is very strongly acid or strongly acid. Depth to influence of volcanic ash is 6 to 14 inches. The organic layers are 3 to 10 inches thick.

The E horizon is neutral or has hue of 7.5YR or 10YR. The horizon has value of 4 to 6 when moist and 6 to 8 when dry. and it has chroma of 0 to 2 when moist or dry.

The Bhs horizon has hue of 5YR or 7.5YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 2 to 6 when moist or dry. It is 0 to 5 percent rock fragments.

The Bs horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. It is 0 to 5 percent rock fragments. Some pedons have a BC horizon.

The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 7 when moist and 7 or 8 when dry, and chroma of 1 to 4 when moist or dry. It is silty clay loam or silt loam.

Sedrowoolley Series

The Sedrowoolley series consists of very deep, moderately well drained soils on alluvial terraces. These soils formed in alluvium. Slopes are 0 to 3 percent. Elevation is 10 to 50 feet. The average annual precipitation is about 32 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 210 days.

These soils are coarse-silty, mixed, nonacid, mesic Aquic Xerofluvents.

Typical pedon of Sedrowoolley silt loam, about 1 mile northwest of Clear Lake, 1,300 feet west and 650 feet south of the northeast corner of sec. 2, T. 34 N., R. 4 E.

Ap1-0 to 4 inches; very dark grayish brown (2.5Y 32) silt loam, grayish brown (2.5Y 5/2) dry; moderate medium subangular blocky structure and moderate medium and fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine continuous tubular pores; slightly acid; abrupt smooth boundary.

Ap2-4 to 10 inches; dark grayish brown (2.5Y 4//2) silt loam, light brownish gray (2.5Y 6/2) dry; weak coarse subangular blocky structure parting to moderate medium and coarse granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine continuous tubular pores; slightly acid; clear wavy boundary.

C1-10 to 16 inches; olive brown (2.5Y 4/4) silt loam, light brownish gray (2.5Y 6/2) dry; few fine very dark grayish brown (10YR 3/2) stains; massive; soft, very friable. slightly sticky and slightly plastic; common very fine roots; common very fine and fine tubular pores; neutral; abrupt smooth boundary.

C2-16 to 32 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam, light brownish gray (2.5Y 6/2) dry; few fine distinct dark yellowish brown (10YR 4/6) mottles; massive; soft, very friable, slightly sticky and nonplastic; few very fine and fine roots; common very fine and fine continuous tubular and irregular pores; distinct fine (5 to 30 millimeters thick) strata of silt loam, fine sand, and very fine sandy loam; layer of organic material 1 inch thick at a depth of 31 inches; slightly acid; abrupt smooth boundary.

C3-32 to 40 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; common fine gray (5Y 5/1) mottles; massive; soft, very friable, slightly sticky and nonplastic; few very fine roots; common fine continuous tubular pores; neutral; abrupt smooth boundary.

C4-40 to 60 inches; olive brown (2.5Y 4/4) very fine sandy loam, light gray (2.5Y 7/2) dry; common fine distinct gray (5Y 5/1) mottles; massive; soft, very friable, slightly sticky and nonplastic; neutral.

The particle size control section averages 4 to 18 percent clay and less than 15 percent sand that is fine or coarser. The control section commonly has strata of fine sand less than 5 inches thick. A layer that has chroma of 2 or less is at a depth of 17 to 30 inches. The profile is slightly acid or neutral throughout.

The Ap horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 5 to 7 when dry. and chroma of 2 to 4 when moist or dry.

The C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 to 4 when moist and 2 or 3 when dry. It is silt loam, very fine sandy loam, or fine sandy loam.

Sehome Series

The Sehome series consists of moderately deep, moderately well drained soils on glacially modified low mountainsides, in valleys, and on glaciated hills. These soils formed in glacial till, loess, and volcanic ash. Slopes are 0 to 65 percent. Elevation is 200 to 1,100 feet. The average annual precipitation is about 55 inches.. the average annual air temperature is about 51 degrees F, and the average frost-free season is 140 to 180 days.

These soils are medial. mesic Andic Xerochrepts.

Typical pedon of Sehome loam, 0 to 8 percent slopes, about 0.75 miles northeast of Alger, 3,100 feet west and 800 feet south of the northeast corner of sec. 8. T. 36 N., R. 4 E.

Oi and Oe-2 inches to 0; undecomposed and partially decomposed deciduous leaves and twigs.

Bw1-0 to 15 inches; strong brown (7.5YR 5/6) loam, reddish yellow (7.5YR 6/6) dry; common strata of dark brown (7.5YR 4/2, 3/2) loam, dark brown (10YR 4/3) dry; moderate coarse subangular blocky structure; soft, friable, slightly sticky and nonplastic; weakly smeary; many fine. medium, and coarse roots; 5 percent pebbles; pH is 11.0 in sodium fluoride; slightly acid; abrupt wavy boundary.

Bw2-15 to 28 inches; yellowish brown (10YR 5/6) gravelly loam, very pale brown (10YR 7/4) dry; common medium distinct grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; soft, friable, slightly sticky and nonplastic; weakly smeary; many fine and medium roots; 20 percent pebbles; pH is 11.0 in sodium fluoride; medium acid; abrupt wavy boundary.

2Cr-28 to 60 inches; light olive gray (5Y 6/2), dense glacial till that crushes to gravelly loam, light gray (2.5Y 7/2) dry; massive; hard, firm, nonsticky and nonplastic; 20 percent pebbles; medium acid.

Depth to dense glacial till and thickness of the volcanic ash influence are 24 to 40 inches. The control section is 15 to 35 percent rock fragments, including 0 to 10 percent cobbles. The individual horizons in the

lower part of the control section are as much as 50 percent rock fragments. Some pedons have an A or C horizon. The profile is strongly acid to slightly acid.

The Bw horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. Below a depth of 10 inches, it is gravelly loam or gravelly silt loam and averages 15 to 35 percent fragments.

The 2Cr horizon is dense glacial till that crushes to gravelly silt loam, gravelly loam, gravelly sandy loam, very gravelly silt loam, very gravelly loam, very gravelly sandy loam, extremely gravelly silt loam, extremely gravelly loam, or extremely gravelly sandy loam and is 15 to 70 percent rock fragments. It has value of 5 to 7 when moist and chroma of 2 to 4 when moist and 2 to 6 when dry.

Skagit Series

The Skagit series consists of very deep, poorly drained soils on flood plains and deltas. Drainage has been altered by use of tile and open ditches. These soils are subject to flooding. They formed in recent alluvium and volcanic ash. Slopes are 0 to 1 percent. Elevation is 0 to 50 feet. The average annual precipitation is about 32 inches,the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 210 days.

These sails are fine-silty. mixed,, nonacid, mesic Typic Fluvaquents.

Typical pedon of Skagit silt loam, 1 mile northwest of Burlington. 600 feet east and 140 feet north of the southwest corner of sec. 30, T. 35 N.. R. 4 E.

Ap1-0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak very fine and fine granular structure; slightly hard, very friable. slightly sticky and slightly plastic; few medium roots and common very fine and fine roots; common very fine discontinuous irregular pores; slightly acid; abrupt smooth boundary.

Ap2-6 to 12 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 63) dry, few fine gray (5Y 5/1) mottles; weak medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine discontinuous irregular pores; slightly acid; abrupt smooth boundary.

Cg1-12 to 20 inches; gray (5Y 6/1) silt loam, light gray (5Y 71) dry; common fine distinct brownish yellow (10YR 6/6) mottles; weak very coarse prismatic structure; slightly hard, friable, sticky and plastic: common very fine roots:, many very fine and fine discontinuous irregular pores and common fine and medium vertical tubular pores; slightly acid; gradual smooth boundary.

Cg2-20 to 26 inches; gray (5Y 5/1) silty clay loam. white (5Y 8/1) dry; many fine and medium yellowish brown (10YR 5/6) and light olive brown (2.5Y 5/6) mottles; weak very coarse prismatic structure parting to weak coarse subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots; common fine vertical tubular pores and common very fine discontinuous irregular pores; common fine dark brown (10YR 3/3) organic stains and very fine organic material; slightly acid; clear smooth boundary.

Cg3-26 to 31 inches; gray (5Y 6/1) silt loam, white (5Y 8 1) dry; many medium prominent brownish yellow (10YR 6/6) and yellowish brown (10YR 5/8) mottles and common medium and large prominent pinkish white (7.5YR 8/2) and pink (7.5YR 8/4) mottles; massive; slightly hard, friable, sticky and plastic; few very fine roots; common very fine discontinuous irregular pores and few fine vertical tubular pores; medium acid; clear smooth boundary.

Cg4-31 to 50 inches; gray (5Y 5/1, 6/1) silt loam, light gray (5Y 7/1) dry; many medium distinct yellowish brown (10YR 5/8) mottles; massive; slightly hard, friable, sticky and plastic; few very fine roots; common very fine tubular concretions and few fine and medium tubular concretions; common medium very dark grayish brown (2.5Y 3/2) organic stains; common fine wood and charcoal fragments; slightly acid.

Cg5-50 to 60 inches; dark gray (5Y 4/1) very fine sandy loam, gray (5Y 6/1) dry; common medium distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard. friable, slightly sticky and nonplastic; neutral.

The control section is less than 15 percent sand that is fine or coarser, 18 to 35 percent clay, and 20 to 50 percent volcanic glass. The water table is at a depth of 0.5 to 2.0 feet from November to March. The profile is medium acid to neutral.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 1 to 3 when moist or dry.

The Cg horizon, above a depth of 40 inches, has hue of 5Y or is neutral. It has value of 4 to 6 when moist and 6 to 8 when dry, and it has chroma of 0 to 1 when moist and 1 or 2 when dry. It is mainly silt loam or silty clay loam, but some pedons have thin strata of sand or

loamy sand. The Cg horizon, below a depth of 40 inches is neutral or has hue of 5Y or 5GY. It has value of 4 to 6 when moist and 6 to 8 when dry, and it has chroma of 0 to 2 when moist or dry. It is mainly very fine sandy loam or silt loam but has strata of sand or loamy fine sand.

Skipopa Series

The Skipopa series consists of very deep, somewhat poorly drained soils on terraces. These soils formed in volcanic ash and loess over glaciolacustrine sediment. Slopes are 0 to 8 percent. Elevation is 150 to 450 feet. The average annual precipitation is about 45 inches., the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 200 days.

These soils are medial over clayey, mixed, mesic Aquic Xerochrepts.

Typical pedon of Skipopa silt loam. 3 to 8 percent slopes, about 2.5 miles southeast of Alger, 2,000 feet east and 800 feet north of the southwest corner of sec. 21, T. 36 N., R. 4 E.

Oi-1.5 inches to 1 inch; undecomposed leaves and twigs.

Oa-1 inch to 0; decomposed organic matter; abrupt smooth boundary.

A-0 to 2 inches; very dark brown (10YR 2/2) silt loam, dark brown (7.5YR 4/2) dry; weak fine subangular blocky structure; soft. very friable, slightly sticky and slightly plastic; common very fine and fine roots and few coarse roots; many very fine and common fine interstitial pores; pH is less than 9.4 in sodium fluoride; medium acid; clear wavy boundary.

Bw1-2 to 8 inches; dark yellowish brown (10YR 3/4) silt loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, very friable. slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots and few coarse roots; common very fine and fine interstitial pores; pH is 10.5 in sodium fluoride; medium acid; clear wavy boundary.

Bw2-8 to 16 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; very few very fine and common fine interstitial pores; few fine silt balls; pH is 10.5 in sodium fluoride; medium acid; gradual irregular boundary.

2C1-16 to 32 inches; gray (5Y 5/1) silty clay, gray (5Y 6/1) dry; common fine distinct strong brown (7.5YR 5/6) mottles; massive; hard, firm, sticky and plastic; pH is 9.8 in sodium fluoride; slightly acid; gradual wavy boundary.

2C2-32 to 60 inches; olive (5Y 5/3) and bluish gray (5B 5/1) silty clay, light gray (2.5Y 7/2) and greenish gray (5G 6/1) dry; massive; hard, very firm, sticky and plastic; pH is less than 9.4 in sodium fluoride; slightly acid.

Thickness of the solum and depth of the influence of volcanic ash are 14 to 24 inches. The control section is 0 to 10 percent rock fragments.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 4 or 5 when dry. and chroma of 2 to 4 when moist or dry. It is medium acid or slightly acid and is 0 to 15 percent pebbles. Some pedons have an E horizon.

The Bw horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist or dry. It is silt loam or silty clay loam and averages 12 to 30 percent clay. The horizon is medium acid or strongly acid.

The 2C horizon has hue of 2.5Y, 5Y, 5G, or 5B, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 1 to 3 when moist or dry. It is silty clay or clay and is 40 to 60 percent clay. The horizon is slightly acid or medium acid.

Skiyou Series

The Skiyou series consists of very deep, well drained soils on glaciated hills. These soils formed in loess, volcanic ash, and glacial till. Slopes are 3 to 30 percent. Elevation is 150 to 1,100 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 220 days.

These soils are medial over loamy-skeletal, mixed, mesic Andic Xerochrepts.

Typical pedon of Skiyou gravelly silt loam, 3 to 15 percent slopes, about 2 miles southeast of Sedro Woolley, 2,100 feet south and 240 feet east of the northwest corner of sec. 33, T. 35 N.. R. 5 E.

Oi-1.5 inches to 0; undecomposed leaves, branches, and twigs.

A-0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky and

slightly plastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; 10 percent rounded pebbles; pH is less than 9.4 in sodium fluoride; medium acid, clear wavy boundary.

Bw1-3 to 14 inches; reddish brown (5YR 4/4) gravelly silt loam. brown (7.5YR 5/4) dry; weak medium granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few very fine and fine roots; common very fine irregular pores; 20 percent rounded pebbles; pH is 12.0 in sodium fluoride; strongly acid; gradual smooth boundary.

Bw2-14 to 23 inches; dark brown (7.5YR 4/4) gravelly loam, yellowish brown (10YR 5/4) dry; weak fine granular structure and weak fine subangular blocky structure; soft. very friable, nonsticky and slightly plastic; weakly smeary, few very fine and fine roots; common fine irregular pores; 20 percent rounded pebbles; pH is 12.0 in sodium fluoride; strongly acid; clear smooth boundary.

2C1-23 to 32 inches; dark yellowish brown (10YR 4/4) very gravelly fine sandy loam, light yellowish brown (2.5Y 6/4) dry; weak medium subangular blocky structure and weak medium granular structure; soft, very friable, nonsticky and nonplastic; very few fine roots; common fine irregular pores; 35 percent rounded pebbles and channery fragments; strongly acid; abrupt smooth boundary.

2C2-32 to 60 inches; light olive brown (2.5Y 5/4) very gravelly fine sandy loam, pale olive (5Y 6/3) dry; massive; soft. friable. nonsticky and nonplastic; very few very fine roots; common very fine irregular pores; 55 percent rounded pebbles and channery fragments; strongly acid.

The solum is 21 to 38 inches thick. The control section is 5 to 12 percent clay. The profile is strongly acid or medium acid.

The A horizon has hue of 7.5YR or 10YR, value of 2 to 4 when moist and 4 or 5 when dry, and chroma of 1 to 3 when moist or dry. Some pedons do not have an A horizon.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 3 or 4 when moist and 4 to 6 when dry. It is silt loam, loam, gravelly silt loam, or gravelly loam. Some pedons have a BC horizon.

The 2C horizon has hue of 10YR, 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 very gravelly sandy loam, very gravelly fine sandy loam, or very gravelly loam.

Skykomish Series

The Skykomish series consists of very deep, somewhat excessively drained soils on terraces and terrace escarpments. These soils formed in volcanic ash and glacial outwash. Slopes are 0 to 65 percent. Elevation is 1,000 to 1,600 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F, and the average frost-free season is 100 to 125 days.

These soils are sandy-skeletal, mixed. frigid Andic Xerochrepts.

Typical pedon of Skykomish very gravelly loam, 0 to 8 percent slopes, about 4 miles southwest of Concrete, 2,440 feet north and 200 feet west of the southeast corner of sec. 25, T. 35 N., R. 8 E.

Oi-3 to 2 inches; undecomposed forest litter.

Oa-2 inches to 0; decomposed forest litter.

Bw1-0 to 1 inch; dark reddish brown (5YR 3/3) very gravelly loam, dark brown (7.5YR 4/4) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common fine roots; many fine irregular pores; 40 percent rounded pebbles; very strongly acid; abrupt wavy boundary.

Bw2-1 inch to 5 inches; strong brown (7.5YR 4/6) very gravelly loam, strong brown (7.5YR 5/6) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; common fine irregular pores; 40 percent rounded pebbles; very strongly acid; clear wavy boundary.

Bw3-5 to 19 inches; strong brown (7.5YR 4/6) very gravelly sandy loam, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; few fine roots; many very fine irregular pores; 40 percent rounded pebbles; strongly acid; clear wavy boundary.

Bw4-19 to 28 inches; strong brown (7.5YR 5/6) very gravelly loamy sand, reddish yellow (7.5YR 6/6) dry; massive; soft, very friable, nonsticky and slightly plastic; weakly smeary; few fine roots; common fine irregular pores; 50 percent rounded pebbles; strongly acid; abrupt smooth boundary.

2C-28 to 60 inches; dark yellowish brown (10YR 4/4) extremely gravelly loamy sand, yellowish brown (10YR 5/6) dry; single grain; loose; few very fine roots; common fine irregular pores; 65 percent rounded pebbles; strongly acid.

Depth of the solum is 15 to 30 inches. The profile is very strongly acid or strongly acid throughout. Some pedons have an E horizon.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, 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 very gravelly loam, very gravelly sandy loam, or very gravelly loamy sand and is 40 to 60 percent rock fragments.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 3 to 6 when moist or dry. It is extremely gravelly coarse sand to very gravelly loamy sand and is 50 to 80 percent rock fragments.

Snohomish Series

The Snohomish series consists of very deep, poorly drained soils on back swamps of flood plains. Drainage has been altered by use of tile and open ditches. These soils formed in alluvium underlain by peat or muck. Slopes are 0 to 2 percent. Elevation is 5 to 30 feet. The average annual precipitation is about 30 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 170 to 220 days.

These soils are fine-silty, mixed, nonacid, mesic Thapto-Histic Fluvaquents.

Typical pedon of Snohomish silt loam, about 2 miles west of Burlington, 1,550 feet east and 150 feet north of the southwest corner of sec. 6, T. 35 N., R. 3 E.

Ap1-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots and few fine and medium roots; few very fine irregular pores; medium acid; abrupt smooth boundary.

Ap2-7 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; few very fine distinct gray (5Y 5/1) mottles and few very fine faint strong brown (7.5YR 5/8) mottles; moderate medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few medium roots; few very fine irregular pores; slightly acid; clear smooth boundary.

Cg1-13 to 23 inches; gray (5Y 5/1) silt loam, light gray (N 70) dry; common fine light olive gray (5Y 6/2) mottles and common medium yellowish brown (10YR 5/6, 5/8) mottles; massive; hard, friable, sticky and plastic; few very fine roots; common very fine tubular pores and few medium and coarse tubular pores; medium acid; abrupt smooth boundary.

Cg2-23 to 30 inches; dark gray (2.5Y 4/0) silt loam, gray (2.5Y 6/0) dry; common fine faint gray (5Y 5/1) mottles and common medium distinct yellowish brown (10YR 5/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few thin (1 to 2 millimeters thick) strata of hemic material; few very fine roots; few fine tubular pores; medium acid; clear smooth boundary.

2Oa1-30 to 38 inches; dark grayish brown (2.5Y 4/2) and strong brown (7.5Y 5/8) sapric material, dark brown (7.5YR 4/2) dry; 20 percent fibers, 5 percent rubbed; massive; 5 percent coarse roots and sticks and 10 percent strata of silt loam; medium acid; clear smooth boundary.

2Oe-38 to 50 inches; very dark grayish brown (2.5YR 3/2) hemic material, very dark gray (10YR 3/1) dry; 60 percent fibers, 20 percent rubbed; massive; medium acid; clear smooth boundary.

2Oa2-50 to 60 inches; black (2.5Y 2/2) sapric material, very dark gray (10YR 3/1) dry; 20 percent fibers, 1 percent rubbed; massive; medium acid; abrupt smooth boundary.

Depth to organic layers ranges from 17 to 36 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 1 or 2 when moist or dry. It is strongly acid to slightly acid.

The Cg horizon has hue of 2.5Y or 5Y or is neutral. It has value of 3 to 5 when moist and 5 to 7 when dry, and it has chroma of 0 to 2 when moist or dry. It is silt loam, silty clay loam, or mucky silt loam. The horizon is strongly acid to slightly acid.

The 2O horizon has hue of 2.5YR, 5YR, 7.5YR, 10YR, or 2.5Y, value of 1 to 5 when moist or dry, and chroma of 0 to 8 when moist or dry. It is sapric or hemic material or is stratified woody mucky peat, muck, sedgy mucky peat, and sedimentary peat. The horizon is strongly acid or medium acid.

Snoqualmie Series

The Snoqualmie series consists of very deep, somewhat excessively drained soils on low river terraces. These soils formed in alluvium. Slopes are 0 to 3 percent. Elevation is 40 to 100 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 50 degrees F, and the

average frost-free season is 140 to 200 days.

These soils are sandy-skeletal, mixed, mesic Dystric Xerorthents.

Typical pedon of Snoqualmie fine sandy loam, about 5 miles southeast of Sedro Woolley, 1,600 feet west and 25 feet north of the southeast corner of sec. 24, T. 35 N., R. 5 E.

A-0 to 8 inches; very dark grayish brown (10YR 3/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; common fine, medium, and coarse roots; common very fine irregular pores; neutral; abrupt smooth boundary.

C1-8 to 17 inches; grayish brown (2.5Y 5/2) loamy sand, light brownish gray (2.5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; common fine, medium, and coarse roots; slightly acid; abrupt smooth boundary.

2C2-17 to 25 inches; gray (N 5/0) very gravelly sand, gray (N 5/0) dry; single grain; loose; few fine, medium, and coarse roots; 40 percent pebbles; neutral; abrupt smooth boundary.

2C3-25 to 60 inches; gray (N 5/0) very gravelly sand, gray (N 5/0) dry; single grain; loose; few coarse roots; 50 percent pebbles; neutral.

Depth to the 2C horizon ranges from 6 to 20 inches. The profile is medium acid to neutral.

The A horizon has hue of 2.5Y or 10YR, value of 2 to 4 when moist and 4 to 6 when dry, and chroma of 1 to 3 when moist and 0 to 2 when dry.

The C1 horizon has hue of 2.5Y or is neutral. It has value of 4 to 6 when moist or dry and chroma of 0 to 2 when moist or dry. It is loamy sand, loamy fine sand, or fine sand.

The 2C horizon is very gravelly sand, extremely gravelly sand, very cobbly sand, or extremely cobbly sand and is 35 to 65 percent rock fragments.

Sorensen Series

The Sorensen series consists of very deep, well drained soils on glaciated mountainsides. These soils formed in colluvium derived from volcanic ash and glacial till that is high in content of phyllite. Slopes are 3 to 65 percent. Elevation is 1,000 to 2,200 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free season is 120 to 150 days.

These soils are medial-skeletal, frigid Andic Xerochrepts.

Typical pedon of Sorensen very gravelly silt loam, 30 to 65 percent slopes, about 6 miles east of Clear Lake, 1,060 feet south and 220 feet east of the northwest corner of sec. 1, T. 34 N., R. 5 E.

Oi-11 inches to 1 inch; needles, twigs, and wood fragments.

Oa-1 inch to 0; decomposed forest litter.

E-0 to 1 inch; dark brown (7.5YR 4/2) gravelly loam, pinkish gray (7.5YR 6/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common very fine irregular pores; 25 percent angular pebbles; strongly acid; abrupt smooth boundary.

Bw1-1 inch to 6 inches; dark brown (7.5YR 4/4) very gravelly silt loam, yellowish brown (10YR 5/6) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; weakly smeary; few very fine and fine roots; common very fine irregular pores; 35 percent angular pebbles and 5 percent cobbles; pH is 10.5 in sodium fluoride; strongly acid; clear wavy boundary.

Bw2-6 to 9 inches; dark yellowish brown (10YR 4/6) very gravelly silt loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few very fine and fine roots; common very fine irregular pores; 40 percent angular pebbles and 15 percent cobbles; pH is 10.5 in sodium fluoride; strongly acid; clear wavy boundary.

Bw3-9 to 18 inches; light olive brown (2.5Y 5/4) extremely gravelly loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; common very fine irregular pores; 45 percent angular pebbles and 20 percent cobbles; pH is 10.5 in sodium fluoride; strongly acid; gradual smooth boundary.

2C1-18 to 25 inches; olive (5Y 5/4) extremely gravelly loam, pale yellow (5Y 7/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine irregular pores; 50 percent angular pebbles and 20 percent cobbles; pH is 10.5 in sodium fluoride; strongly acid; gradual smooth boundary.

2C2-25 to 60 inches; pale olive (5Y 6/4) extremely gravelly loam, pale yellow (5Y 8/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine irregular pores; 45 percent angular pebbles and 20 percent cobbles; strongly acid.

Depth of the solum is 18 to 24 inches. The profile is

strongly acid or very strongly acid throughout. Some pedons do not have an E horizon.

The Bw horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist or dry. It is very gravelly loam, extremely gravelly loam, very gravelly silt loam, or extremely gravelly silt loam and is 40 to 70 percent rock fragments.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist or dry. It is very gravelly loam, extremely gravelly loam, very gravelly fine sandy loam, or extremely gravelly fine sandy loam and is 50 to 70 percent rock fragments.

Springsteen Series

The Springsteen series consists of moderately deep, well drained soils on glacially modified mountains. These soils formed in volcanic ash, glacial till, and colluvium derived from phyllite. Slopes are 30 to 65 percent. Elevation is 2,000 to 3,100 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 42 degrees F, and the average frost-free season is 90 to 120 days.

These soils are medial-skeletal Typic Cryorthods.

Typical pedon of Springsteen very gravelly loam, 30 to 65 percent slopes, about 14 miles south of Marblemount. 2,400 feet south and 1,100 feet west of the northeast corner of sec. 24, T. 33 N., R. 10 E.

Oi-5 to 2 inches; undecomposed twigs and needles.

Oa-2 inches to 0; decomposed forest litter.

E-0 to 2 inches; brown (7.5YR 5/2) gravelly silt loam, pinkish gray (7.5YR 7/2) dry; massive; soft, very friable, nonsticky and slightly plastic; few fine roots; common very fine irregular pores; 20 percent pebbles; pH is less than 9.2 in sodium fluoride; very strongly acid; abrupt smooth boundary.

Bs1-2 to 6 inches; dark reddish brown (5YR 3/4) very gravelly loam, reddish yellow (7.5YR 6/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; 50 percent pebbles; pH is 12.0 in sodium fluoride; strongly acid; abrupt wavy boundary.

Bs2-6 to 17 inches; strong brown (7.5YR 4/6) very gravelly loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine roots; many fine irregular pores; 55 percent pebbles; pH is 12.0 in sodium fluoride; strongly acid; clear smooth boundary.

BC-17 to 23 inches; light olive brown (2.5Y 5/6) very gravelly loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; very few very fine roots; many very fine irregular pores; 55 percent pebbles; pH is 12.0 in sodium fluoride; strongly acid; gradual wavy boundary.

2C-23 to 35 inches; light yellowish brown (2.5Y 6/4) extremely channery loam, pale yellow (5Y 7/3) dry; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; common fine irregular pores; 70 percent channery fragments; pH is 12.6 in sodium fluoride; strongly acid; abrupt wavy boundary.

R-35 inches; fractured phyllite.

Depth to bedrock is 20 to 40 inches. The profile is very strongly acid or strongly acid throughout.

The E horizon has hue of 7.5YR or 10YR, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist or dry.

The Bs and BC horizons have hue of 5YR, 7.5YR, 10YR, or 2.5Y, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist or dry. They are very gravelly silt loam, extremely gravelly silt loam, very gravelly loam, or extremely gravelly loam and are 40 to 70 percent rock fragments.

The 2C horizon has hue of 2.5Y or 5Y, value of 5 or 6 when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist or dry. It is very channery silt loam, extremely channery loam, or extremely channery sandy loam and is 50 to 70 percent rock fragments.

Squires Series

The Squires series consists of moderately deep, well drained soils on glacially modified mountains. These soils formed in colluvium derived from phyllite, volcanic ash, and glacial till that is high in content of phyllite. Slopes are 30 to 65 percent. Elevation is 400 to 1,500 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 160 to 200 days.

These soils are medial-skeletal, mesic Andic Xerochrepts.

Typical pedon of Squires very gravelly silt loam, 30 to 65 percent slopes, about 3 miles northwest of Alger, 1,500 feet south and 560 feet east of the northwest corner of sec. 2, T. 36 N., R. 3 E.

Oi-2 inches to 1 inch; undecomposed forest litter.
Oa-1 inch to 0; decomposed forest litter.
E-0 to 1 inch; dark brown (10YR 4/3) very gravelly silt loam, pale brown (10YR 6/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; few very fine and fine irregular pores; 50 percent angular and rounded pebbles; pH is less than 9.2 in sodium fluoride; strongly acid; abrupt smooth boundary.
Bw1-1 inch to 6 inches; dark yellowish brown (10YR 4/6) very gravelly silt loam, yellowish brown (10YR 5/6) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common *very* fine and fine roots and few coarse roots; common very fine and fine irregular pores; 40 percent rounded and angular pebbles; pH is 12.0 in sodium fluoride; medium acid; gradual irregular boundary.
Bw2-6 to 17 inches; strong brown (7.5YR 4/6) very gravelly silt loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and few fine roots; common very fine and fine irregular pores; 50 percent rounded and angular pebbles; pH is 12.0 in sodium fluoride; medium acid; clear wavy boundary.
C1-17 to 26 inches; light olive brown (2.5Y 5/4) very gravelly loam, light yellowish brown (2.5Y 6/4) dry; weak moderate and coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; few very fine irregular pores; 40 percent rounded and angular pebbles; pH is 12.0 in sodium fluoride; medium acid; clear irregular boundary.
C2-26 to 32 inches; grayish brown (2.5Y 5/2) very gravelly loam, light gray (2.5Y 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; very few fine tubular pores; 40 percent angular and rounded pebbles; pH is 10.5 in sodium fluoride; medium acid; abrupt irregular boundary.
2R-32 inches; fractured phyllite.

Depth to bedrock is 24 to 40 inches. The profile is very strongly acid to medium acid throughout.

The E horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry. Some pedons do not have an E horizon.

The Bw horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 3 to 6 when moist and 4 to 6 when dry. It is very gravelly loam, very gravelly silt loam, or extremely gravelly sandy loam and averages 40 to 70 percent rock fragments.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist or dry. It is very gravelly loam, very gravelly silt loam, or extremely gravelly sandy loam and averages 40 to 70 percent rock fragments.

Sumas Series

The Sumas series consists of very deep, poorly drained soils on flood plains and deltas. Drainage has been altered by tiling. These soils are subject to flooding. They formed in alluvium. Slopes are 0 to 2 percent. Elevation is 0 to 50 feet. The average annual precipitation is about 32 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 210 days.

These soils are fine-silty over sandy or sandy-skeletal, mixed, nonacid, mesic Aeric Fluvaquents.

Typical pedon of Sumas silt loam. 5 miles south of Mount Vernon, 900 feet east and 100 feet south of the northwest corner of sec. 17, T. 33 N., R. 4 E.

Ap1-0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate fine and medium granular structure; hard, friable, sticky and plastic; common very fine roots; few very fine irregular pores; neutral; clear wavy boundary.
Ap2-6 to 13 inches; very dark grayish brown (10YR 3/2) silty clay loam, light brownish gray (10YR 6/2) dry; common fine distinct gray (5Y 5/1) mottles; weak coarse subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; common very fine irregular pores; neutral; abrupt smooth boundary.
C1-13 to 16 inches; gray (10YR 6/1) silt loam, white (2.5Y 8/1) dry; common medium prominent yellowish brown (10YR 5/6) mottles; weak coarse angular blocky structure; hard, friable, sticky and plastic; common very fine roots; common very fine irregular pores; neutral; abrupt smooth boundary.
2C2-16 to 30 inches; gray (5Y 5/1) loamy sand, white (2.5Y 8/1) dry; common medium prominent strong brown (7.5YR 5/6) mottles; single grain; loose; few very fine roots; neutral; abrupt smooth boundary.
2C3-30 to 60 inches; dark gray (5Y 4/1) coarse sand, gray (5Y 5/1) dry; single grain; loose; 10 percent fine pebbles; neutral.

Depth to sand or gravelly sand ranges from 14 to 36 inches. The upper part of the particle size control section averages 18 to 35 percent clay and less than 15 percent fine sand or coarser. The profile is medium acid to neutral throughout.

The A horizon has hue of 10YR or 2.5Y, value of 2 to 4 when moist and 4 to 7 when dry, and chroma of 1 or 2 when moist or dry.

The C1 horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 when moist and 5 to 8 when dry, and chroma of 1 or 2 when moist or dry. It is silt loam or silty clay loam.

The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5 when moist and 4 to 8 when dry, and chroma of 1 to 4 when moist or dry. It is loamy sand, coarse sand, or gravelly sand.

Swinomish Series

The Swinomish series consists of moderately deep, moderately well drained soils on ridges of glacial till plains. These soils formed in glacial till and an admixture of loess and volcanic ash. Slopes are 0 to 30 percent. Elevation is 100 to 1,200 feet. The average annual precipitation is about 23 inches. the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 210 days.

These soils are medial-skeletal, mesic Andic Xerochrepts.

Typical pedon of Swinomish gravelly loam, 0 to 8 percent slopes, about 1 mile west of La Conner, 260 feet north and 2,620 feet east of the southwest corner of sec. 26. T. 34 N.. R. 2 E.

Oi-1 inch to 0; needles, leaves, and twigs.

A-0 to 3 inches; dark brown (7.5YR 3/2) gravelly loam, brown (7.5YR 5/2) dry; weak fine granular structure; soft. very friable. nonsticky and slightly plastic; weakly smeary; common very fine and fine roots; 15 percent pebbles and 5 percent cobbles; pH is 10.5 in sodium fluoride. slightly acid; clear smooth boundary.

Bw1 -3 to 11 inches; strong brown (7.5YR 4/6) gravelly loam, reddish yellow (7.5YR 6/6) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common very fine, fine, medium, and coarse roots; 20 percent pebbles and 5 percent cobbles; pH is 11.0 in sodium fluoride; slightly acid; clear smooth boundary.

Bw2-11 to 20 inches; strong brown (7.5YR 5/6) gravelly loam, light yellowish brown (10YR 6/4) dry: weak medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; 15 percent pebbles and 5 percent cobbles; pH is 10.5 in sodium fluoride; slightly acid; clear smooth boundary.

BC-20 to 24 inches; yellowish brown (10YR 5/4) very gravelly fine sandy loam, light yellowish brown (2.5Y 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine, medium, and coarse roots; 25 percent pebbles and 10 percent cobbles; pH is 11.0 in sodium fluoride; slightly acid; clear smooth boundary.

C1-24 to 29 inches; light olive brown (2.5Y 5/4) very gravelly fine sandy loam, light yellowish brown (2.5Y 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; common fine, medium, and coarse roots; 50 percent pebbles; pH is 11.0 in sodium fluoride; slightly acid; abrupt smooth boundary.

C2-29 to 31 inches; light olive brown (2.5Y 5/4) very gravelly sandy loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct yellowish red (5YR 5/8) mottles; massive; soft, very friable, nonsticky and nonplastic; few fine, medium, and coarse roots; 60 percent pebbles; pH is 11.0 in sodium fluoride; slightly acid; abrupt smooth boundary.

Cr-31 to 60 inches; olive gray (5Y 5/2), dense glacial till that crushes to very gravelly sandy loam, light gray (5Y 7/2) dry; massive; hard, firm, nonsticky and nonplastic; 50 percent pebbles; slightly acid.

Depth to dense glacial till is 25 to 40 inches. The control section averages 35 to 50 percent pebbles and cobbles. The profile is slightly acid or neutral throughout.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. It is gravelly loam, very gravelly sandy loam, or very gravelly fine sandy loam.

The BC horizon has hue of 10YR or 2.5Y, value of 5 or 6 when moist or dry, and chroma of 3 or 4 when moist or dry. It is very gravelly fine sandy loam or very gravelly sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 when moist and 6 or 7 when dry, and chroma of 3 or 4 when moist or dry. It is very gravelly sandy loam or very gravelly fine sandy loam.

The Cr horizon consists of dense glacial till that crushes to very gravelly sandy loam or very gravelly loamy fine sand.

Tacoma Series

The Tacoma series consists of very deep, very poorly drained soils on flood plains and deltas. Drainage has been altered in some areas by use of tile and open ditches. These soils formed in stratified alluvium and volcanic ash and thin lenses of organic material. Slopes are 0 to 2 percent. Elevation is 1 foot below sea level to 10 feet above sea level. The average annual precipitation is about 25 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 200 days.

These soils are coarse-silty, mixed, acid, mesic Sulfic Fluvaquents.

Typical pedon of Tacoma silt loam, drained, about 1 mile northeast of Pigeon Point, 1,370 feet east and 75 feet south of the northwest corner of sec. 9. T. 36 N., R. 3E.

Ap-0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; moderate coarse granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; few very fine irregular pores; strongly acid:, abrupt smooth boundary.

Cg1-9 to 16 inches; light brownish gray (10YR 6/2) silt loam. white (10YR 8/2) dry; common medium prominent strong brown (7.5YR 5/6) mottles; moderate medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine irregular pores; discontinuous strata of decomposed organic matter 2 centimeters thick in middle of horizon; very strongly acid; abrupt smooth boundary.

Cg2-16 to 25 inches; gray (10YR 5/1) silt loam, white (10YR 8/1); common medium prominent brownish yellow (10YR 6/6) mottles; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine irregular pores; strata of black (10YR 2/1) peat 10 to 20 millimeters thick; very strongly acid; abrupt wavy boundary.

Cg3-25 to 33 inches; gray (2.5Y 6/1) silt loam, white (10YR 8/1) dry; common medium prominent brownish yellow (10YR 6/6) mottles; moderate coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine and fine irregular pores and few fine tubular pores; common thin (1 millimeter thick) dark reddish brown (5YR 3/2) coatings on faces of peds; extremely acid; clear wavy boundary.

Cg4-33 to 50 inches; gray (10YR 5/1) silty clay loam, white (10YR 8/1) dry; many medium and coarse prominent brownish yellow (10YR 6/6) mottles; weak very coarse prismatic structure and moderate coarse angular blocky structure; hard, friable, sticky and plastic; few very fine roots; common very fine and fine irregular pores and few fine tubular pores; common thin (1 millimeter thick) dark reddish brown (5YR 3/2) coatings on faces of peds; extremely acid; abrupt smooth boundary.

Cg5-50 to 60 inches; gray (N 6/0) silt loam, light gray (N 7/0) dry; massive; hard, friable, slightly sticky and slightly plastic; common very fine and fine irregular pores; extremely acid.

The profile is extremely acid or very strongly acid below the Ap horizon. Lenses of organic material make up less than 10 inches of the profile.

The Ap horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist, and chroma of 1 or 2 when moist or dry. It is extremely acid to strongly acid.

The Cg horizon has hue of 10YR, 2.5Y, or 5Y or is neutral. It has value of 4 to 6 when moist and 5 to 8 when dry, and it has chroma of 0 to 2 when moist or dry. The upper part is silt loam or very fine sandy loam, and the lower part is silt loam, silty clay loam, or clay.

Thornton Series

The Thornton series consists of very deep, somewhat poorly drained soils on terraces. These soils formed in glaciolacustrine sediment derived from talc. Slopes are 0 to 3 percent. Elevation is 150 to 250 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 180 to 220 days.

These soils are fine-silty, serpentinitic, nonacid, mesic Aquic Xerorthents.

Typical pedon of Thornton silt loam, about 6 miles east of Sedro Woolley, 500 feet south and 50 feet west of the northeast corner of sec. 25, T. 35 N., R. 5 E.

Oi-2 inches to 1 inch; leaves, twigs, and needles.

Oa-1 inch to 0; decomposed plant material.

A-0 to 2 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; massive; hard, firm, slightly sticky and plastic; few very fine and fine roots; very

few very fine irregular pores; medium acid; abrupt smooth boundary.

C1-2 to 45 inches; white (2.5Y 8/2) silt loam, white (10YR 8/1) dry; many medium distinct light yellowish brown (10YR 6/4) mottles; massive; hard. firm, slightly sticky and plastic; few very fine and fine roots; very few very fine pores; medium acid; gradual irregular boundary.

C2-45 to 60 inches; light gray (5Y 7/2) silt loam, white (5Y 8/1) dry; many medium prominent brownish yellow (10YR 6/6) mottles; massive; very hard, firm, slightly sticky and slightly plastic; medium acid.

The control section is 18 to 25 percent clay.

The A horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. Some pedons do not have an A horizon.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 6 to 8 when moist or dry, and chroma of 0 to 2 when moist or dry. Mottles increase in size and contrast in the lower part of the horizon.

Tisch Series

The Tisch series consists of very deep, very poorly drained soils in narrow stream drainageways. These soils formed in mixed volcanic ash, diatomaceous earth, and stream alluvium. Slopes are 0 to 2 percent. Elevation is 50 to 250 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 200 days.

These soils are medial, nonacid, mesic Mollic Andaquepts.

Typical pedon of Tisch silty clay loam, 0.5 mile north of Big Lake, 2.800 feet east and 700 feet north of the southwest corner of sec. 25, T. 34 N., R. 4 E.

Ap-0 to 11 inches; dark olive gray (5Y 3/2) silty clay loam. grayish brown (2.5Y 5/2) dry; moderate medium granular structure; hard, firm, sticky and plastic; common very fine and fine roots; common very fine vesicular pores; neutral; abrupt smooth boundary.

Cg1-11 to 17 inches; light gray (N 7/1) silt loam, white (N 8/1) dry; many medium prominent yellowish brown (10YR 5/6) mottles; massive; hard, friable, sticky and plastic; common very fine roots; few very fine vesicular pores; very low bulk density when dry; pH is 10.3 in sodium fluoride:, neutral; clear smooth boundary.

Cg2-17 to 38 inches; light gray (10YR 7/1) silt loam, white (N 8/1) dry; massive; hard, friable, sticky and plastic; few very fine roots; few very fine vesicular pores; very low bulk density when dry; pH is 10.3 in sodium fluoride; neutral; clear smooth boundary.

Cg3-38 to 60 inches; gray (2.5Y 6/0) and very dark grayish brown (10YR 3/2), stratified silt loam and hemic material, grayish brown (2.5Y 5/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; very low bulk density; pH is 10.3 in sodium fluoride; neutral.

The A horizon has hue of 2.5Y or 5Y, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 or 2 when moist or dry.

The Cg horizon is neutral or has hue of 10YR or 2.5Y. It has value of 2 to 8 when moist and 4 to 8 when dry, and it has chroma of 0 to 2 when moist or dry. It is silt loam or silt and has lenses of peat or muck that make up less than 10 inches of the horizon.

Tokul Series

The Tokul series consists of moderately deep, moderately well drained soils on glacially modified hills and mountainsides. These soils formed in glacial till, loess, and volcanic ash. Slopes are 0 to 65 percent. Elevation is 200 to 1,100 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 150 to 200 days.

These soils are medial, mesic Dystric Entic Durochrepts.

Typical pedon of Tokul gravelly loam, 0 to 8 percent slopes, about 5 miles east of McMurray, 2,580 feet north and 2,060 feet east of the southwest corner of sec. 20, T. 33 N., R. 5 E.

Oi-1 inch to 0; forest litter of leaves, needles, and twigs.

A-0 to 2 inches; very dark grayish brown (10YR 3/2) gravelly loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; common very fine irregular pores; 20 percent rounded pebbles; pH is 9.4 in sodium fluoride; medium acid; abrupt smooth boundary.

Bw1-2 to 5 inches; dark brown (7.5YR 3/4) gravelly loam, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly

smeary; few fine roots; common very fine irregular pores; 20 percent rounded pebbles; pH is 11.5 in sodium fluoride; strongly acid; abrupt wavy boundary.

Bw2-5 to 10 inches; dark brown (7.5YR 4/4) 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 medium roots; common very fine irregular pores; 20 percent rounded pebbles; pH is 12.0 in sodium fluoride; strongly acid; clear wavy boundary.

Bw3-10 to 34 inches; dark yellowish brown (10YR 4/4) 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 medium roots; common very fine tubular pores; 20 percent rounded pebbles; pH is 10.5 in sodium fluoride; strongly acid; abrupt wavy boundary.

C-34 to 39 inches; light olive brown (2.5Y 5/4) gravelly fine sandy loam, pale yellow (2.5Y 7/4) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles. brownish yellow (10YR 6/6) dry; massive; hard, very friable, nonsticky and nonplastic; weakly smeary; few fine roots; few very fine tubular pores; 20 percent rounded pebbles and 5 percent cobbles; pH is 10.0 in sodium fluoride; strongly acid; abrupt smooth boundary.

2Cgm-39 to 60 inches; olive brown (2.5Y 4/4), silica-cemented glacial till that crushes to very gravelly sandy loam, light yellowish brown (2.5Y 6/4) dry; massive; very hard, very firm, nonsticky and nonplastic; 40 percent rounded pebbles and 5 percent cobbles; discontinuous layer of silica and iron 5 to 10 millimeters thick on surface of horizon; medium acid.

Depth to silica-cemented till ranges from 20 to 40 inches. The profile is strongly acid or medium acid throughout.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. Some pedons have an E horizon.

The Bw horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 4 to 6 when moist or dry. It commonly is gravelly loam or gravelly silt loam but is gravelly sandy loam in the lower part in some pedons. It is 20 to 30 percent coarse fragments and 0 to 10 percent weakly cemented concretions.

The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist or dry. It is gravelly sandy loam or gravelly loam.

The 2Cqm horizon is cemented glacial till that crushes to gravelly sandy loam, very gravelly sandy loam, or very gravelly loamy sand.

Vanzandt Series

The Vanzandt series consists of moderately deep, moderately well drained soils on glacially modified plains and mountainsides. These soils formed in volcanic ash and glacial till. Slopes are 0 to 65 percent. Elevation is 250 to 1,500 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 140 to 180 days.

These soils are medial-skeletal, mesic Andic Xerochrepts.

Typical pedon of Vanzandt very gravelly loam, 30 to 65 percent slopes, about 5 miles northeast of Sedro Woolley, 1,820 feet north and 640 feet west of the southeast corner of sec. 32, T. 36 N., R. 5 E.

Oi-9 inches to 0; needles, twigs, and wood fragments.

A-0 to 1 inch; very dark grayish brown (10YR 3/2) very gravelly silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; 50 percent rounded pebbles; pH is 9.4 in sodium fluoride; medium acid; abrupt wavy boundary.

Bw1-1 to 11 inches; dark brown (7.5YR 4/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common fine and medium roots; common very fine irregular pores; 35 percent rounded pebbles and 10 percent cobbles; pH is 11.5 in sodium fluoride; medium acid; clear wavy boundary.

Bw2-11 to 20 inches; dark brown (7.5YR 4/4) very gravelly loam, brownish yellow (10YR 6/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; few fine and medium roots; common fine irregular pores; 30 percent rounded pebbles and 15 percent cobbles; pH is 11.5 in sodium fluoride; medium acid; clear smooth boundary.

Bw3-20 to 24 inches; yellowish brown (10YR 5/6) very gravelly loam, yellow (10YR 7/6) dry; weak fine

subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; few fine roots; common very fine irregular pores; 40 percent rounded pebbles and 10 percent cobbles; pH is 11.5 in sodium fluoride; medium acid; abrupt smooth boundary.

2C-24 to 36 inches; olive brown (2.5Y 4/4) very gravelly loam, pale yellow (5Y 7/3) dry; weak medium subangular blocky structure; soft, very friable. nonsticky and slightly plastic; few very fine roots; few very fine irregular pores; 40 percent rounded pebbles; pH is 11.0 in sodium fluoride; medium acid; abrupt smooth boundary.

2Cr-36 to 60 inches; olive gray (5Y 5/2), dense glacial till that crushes to very gravelly loam, light gray (5Y 7/1) dry; massive; hard, very firm, nonsticky and slightly plastic; very few very fine roots in cracks; few very fine irregular pores; 35 percent rounded pebbles; medium acid.

The depth to dense glacial till is 24 to 40 inches.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 2 to 4 when moist or dry. It is 35 to 50 percent rock fragments and is strongly acid to medium acid.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 3 to 6 when moist or dry. It is very gravelly loam or very gravelly silt loam and is 35 to 60 percent coarse fragments. The horizon is medium acid or slightly acid.

The 2C and 2Cr horizons have hue of 2.5Y or 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 to 4 when moist or dry. They are very gravelly loam or very gravelly sandy loam and are medium acid or slightly acid.

Whistle Series

The Whistle series consists of deep, well drained soils on glacially modified hills. These soils formed in colluvium derived from argillite, serpentine, basalt, and glacial till and an admixture of volcanic ash and loess. Slopes are 30 to 65 percent. Elevation is 20 to 1,300 feet. The average annual precipitation is about 20 inches, the average annual air temperature is about 50 degrees F. and the average frost-free season is 160 to 210 days.

These soils are loamy-skeletal, mixed, mesic Andic Xerochrepts.

Typical pedon of a Whistle very gravelly loam in an area of Whistle-Fidalgo-Rock outcrop complex, 30 to 65 percent slopes, about 3 miles south of Anacortes, 700 feet east and 1,200 feet north of the southwest corner of sec. 6, T. 34 N., R. 2 E.

Oi-1 inch to 0; needles, leaves, and twigs.

A-0 to 3 inches; very dark brown (10YR 2/2) very gravelly loam, grayish brown (10YR 5/2) dry; weak coarse granular structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; common fine, medium, and coarse roots; 55 percent angular and rounded pebbles; neutral; abrupt wavy boundary.

Bw1-3 to 12 inches; brown (7.5YR 5/4) very gravelly sandy loam, light yellowish brown (10YR 6/4) dry; moderate coarse subangular blocky structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; common fine, medium, and coarse roots; 40 percent angular and rounded pebbles; slightly acid; clear irregular boundary.

Bw2-12 to 26 inches; brown (10YR 5/3) extremely gravelly sandy loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine and fine roots; 70 percent angular and rounded pebbles and 10 percent weakly cemented fragments of glacial till; slightly acid; clear wavy boundary.

C1-26 to 36 inches; dark grayish brown (2.5Y 4/2) very gravelly sandy loam, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, slightly sticky and nonplastic; few fine roots; 45 percent angular and rounded pebbles; slightly compact; slightly acid; clear wavy boundary.

C2-36 to 49 inches; olive brown (2.5Y 4/4) extremely gravelly sandy loam, light yellowish brown (2.5Y 6/3) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; 50 percent angular and rounded pebbles and 15 percent cobbles; slightly acid; abrupt irregular boundary.

R-49 inches; hard argillite.

Depth to hard bedrock is 40 to 60 inches. The control section ranges from 35 to 85 percent coarse fragments and consists of gravel and some cobbles. The profile is slightly acid or neutral throughout.

The A horizon has hue of 10YR or 7.5YR, value of 2 to 4 when moist and 4 to 8 when dry, and chroma of 1 to 3 when moist or dry. Some pedons have a thin E horizon.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 to 6 when moist or dry, and chroma of 3 to 6

when moist or dry. It is very gravelly loam, very gravelly fine sandy loam, very gravelly sandy loam, or extremely gravelly sandy loam.

The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 6 when moist or dry, and chroma of 2 to 4 when moist or dry. It is very gravelly sandy loam, extremely gravelly sandy loam, or very cobbly sandy loam.

The R horizon is hard, unweathered serpentine, argillite, or basalt.

Wickersham Series

The Wickersham series consists of very deep, well drained soils on alluvial fans and terraces. These soils formed in alluvium derived from phyllite. Slopes are 0 to 8 percent. Elevation is 150 to 400 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 150 to 200 days.

These soils are coarse-loamy over sandy or sandy-skeletal, mixed, mesic Dystric Xerochrepts.

Typical pedon of Wickersham silt loam, 0 to 8 percent slopes, about 4 miles south of Wickersham, 440 feet north and 400 feet west of the southeast corner of sec. 13. T. 36 N.. R. 4 E.

Oi-2 inches to 0; leaves and twigs.

A-0 to 7 inches; dark olive gray (5Y 3/2) silt loam, grayish brown (2.5Y 5/2) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine irregular pores; 10 percent pebbles; medium acid; abrupt smooth boundary.

Bw1-7 to 18 inches; olive gray (5Y 4/2) silt loam, light olive gray (5Y 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and coarse roots; common very fine irregular pores; 10 percent pebbles; slightly acid; abrupt smooth boundary.

Bw2-18 to 24 inches; olive gray (5Y 4/2) channery loam, light olive gray (5Y 6/2) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; common very fine irregular pores; 15 percent channery fragments; medium acid; abrupt smooth boundary.

2C1-24 to 33 inches; olive gray (5Y 4/2) very channery loamy sand, light olive gray (5Y 6/2) dry; single grain; loose; few very fine roots; 35 percent channery fragments and 25 percent rounded pebbles; medium acid; clear wavy boundary.

2C2-33 to 60 inches; very dark gray (N 3/0) extremely channery sand, gray (5Y 5/1) dry; single grain; loose; 40 percent channery fragments and 30 percent rounded pebbles; slightly acid.

The thickness of the solum and depth to sand and channery fragments are 15 to 33 inches. The upper part of the control section is 6 to 18 percent clay. The profile is medium acid or slightly acid throughout.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 1 or 2 when moist or dry.

The Bw horizon has hue of 2.5Y or 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist or dry. It is silt loam, gravelly silt loam, loam, or channery loam and is 10 to 25 percent rock fragments.

The 2C horizon has hue of 2.5Y or 5Y or is neutral. It has value of 3 to 5 when moist and 5 or 6 when dry, and it has chroma of 0 to 2 when moist or dry. It is very channery loamy sand, very channery sand, or extremely channery sand and is 40 to 70 percent rock fragments.

Winston Series

The Winston series consists of very deep, well drained soils on terraces. These soils formed in volcanic ash, loess, and glacial outwash. Slopes are 0 to 8 percent. Elevation is 250 to 1,000 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 140 to 180 days.

These soils are medial over sandy or sandy-skeletal, mixed, mesic Andic Xerochrepts.

Typical pedon of Winston gravelly silt loam, 0 to 8 percent slopes, about 2 miles west of Rockport, 1,200 feet north and 1,600 feet east of the southwest corner of sec. 27, T. 35 N., R. 9 E.

Oi-4 inches to 0; needles and twigs.

E-0 to 1 inch; dark brown (7.5YR 4/2) gravelly silt loam, pinkish gray (7.5YR 6/2) dry; massive; soft, very friable, nonsticky and slightly plastic; few very fine roots; few very fine irregular pores; 20 percent rounded pebbles; pH is less than 9.2 in sodium fluoride; strongly acid; abrupt wavy boundary.

Bw1-1 to 2 inches; dark reddish brown (5YR 3/3) gravelly silt loam, reddish brown (5YR 4/4) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; weakly smeary; common very fine roots; common very fine irregular pores; 25 percent rounded

pebbles; pH is 11.0 in sodium fluoride; strongly acid; abrupt wavy boundary.

Bw2-2 to 6 inches; yellowish red (5YR 5/6) gravelly silt loam, reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; weakly smeary; common fine roots; common fine irregular pores; 25 percent rounded pebbles; pH is 11.0 in sodium fluoride; strongly acid; clear wavy boundary.

Bw3-6 to 12 inches; strong brown (7.5YR 4/6) gravelly silt loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; weakly smeary; common fine roots; common very fine irregular pores; 25 percent rounded pebbles; pH is 10.5 in sodium fluoride; strongly acid; clear wavy boundary.

Bw4-12 to 24 inches; dark brown (7.5YR 4/4) gravelly silt loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; weakly smeary; few very fine roots; common very fine irregular pores; 30 percent rounded pebbles; pH is 11.0 in sodium fluoride; strongly acid; abrupt wavy boundary.

2C-24 to 60 inches; light olive brown (2.5Y 5/6) extremely gravelly sand, pale yellow (2.5Y 7/4) dry; single grain; loose; many fine irregular pores; 60 percent rounded pebbles and 10 percent cobbles; medium acid.

The depth to the 2C horizon is 16 to 30 inches. The profile is strongly acid or medium acid throughout.

The E horizon has hue of 7.5YR or 10YR, value of 2 to 5 when moist and 4 to 6 when dry, and chroma of 2 or 3 when moist or dry.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, 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 loam, gravelly silt loam, silt loam, or gravelly sandy loam and is 10 to 30 percent coarse fragments.

The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 3 to 6 when moist or dry. It is very gravelly sand, extremely gravelly coarse sand, or extremely gravelly sand and is 40 to 70 percent coarse fragments.

Wiseman Series

The Wiseman series consists of very deep, somewhat excessively drained soils on alluvial fans. These soils formed in alluvium derived from phyllite. Slopes are 0 to 8 percent. Elevation is 200 to 900 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 51 degrees F, and the average frost-free season is 160 to 220 days.

These soils are sandy-skeletal, mixed, mesic Dystric Xerorthents.

Typical pedon of Wiseman channery sandy loam, 0 to 8 percent slopes, about 1 mile north of Marblemount, 755 feet north and 565 feet west of the southeast corner of sec. 1, T. 35 N., R. 10 E.

A-0 to 4 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; soft, friable, nonsticky and nonplastic; few fine roots; many very fine irregular pores; 5 percent phyllite channery fragments; medium acid; abrupt smooth boundary.

C-4 to 60 inches; dark olive gray (5Y 3/2) extremely channery sand, olive gray (5Y 5/2) dry; single grain; loose; common fine and few coarse roots; 70 percent phyllite channery fragments; medium acid.

Thickness of the solum is 4 to 7 inches. The profile is slightly acid or medium acid throughout.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. Some pedons do not have an A horizon.

The C horizon has hue of 10YR, 2.5Y, or 5Y, and it has value of 2 or 3 when moist and 5 or 6 when dry. It is very channery loamy sand, extremely channery sand, or extremely channery loamy sand and is 40 to 80 percent phyllite channery fragments. Some pedons have strata of fine sand or silt.

Wollard Series

The Wollard series consists of moderately deep, moderately well drained soils on glacially modified mountains. These soils formed in glacial till influenced by phyllite and overlain by colluvium containing volcanic ash. Slopes are 3 to 65 percent. Elevation is 2,000 to 3,100 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 40 degrees F, and the average frost-free season is 90 to 120 days.

These soils are medial Typic Cryorthods.

Typical pedon of Wollard gravelly silt loam, 30 to 65 percent slopes, about 5 miles northwest of Lyman, 900 feet south and 780 feet east of the northwest corner of sec. 23, T. 36 N., R. 5 E.

Oi-4 inches to 0; undecomposed forest litter.

E-0 to 4 inches; light brownish gray (10YR 6/2) gravelly silt loam, light gray (10YR 7/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common very fine irregular pores; 20 percent pebbles; pH is less than 9.2 in sodium fluoride; very strongly acid; abrupt wavy boundary.

Bs-4 to 11 inches; yellowish brown (10YR 5/6) gravelly silt loam, brownish yellow (10YR 6/6) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine roots; common very fine irregular pores; 30 percent pebbles; pH is 11.0 in sodium fluoride; very strongly acid; clear wavy boundary.

2BC-11 to 21 inches; light olive brown (2.5Y 5/4) gravelly loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; slightly hard, friable. slightly sticky and slightly plastic; few very fine roots; common fine irregular pores; 30 percent pebbles; pH is 11.5 in sodium fluoride; strongly acid; clear wavy boundary.

2C-21 to 35 inches; pale olive (5Y 6/3) gravelly loam, white (5Y 8/2) dry; weak coarse subangular blocky structure; slightly hard, friable, sticky and slightly plastic; very few very fine roots; few very fine irregular pores; 30 percent pebbles; pH is 10.5 in sodium fluoride; strongly acid; abrupt smooth boundary.

2Cr-35 to 60 inches; pale olive (5Y 6/3), dense glacial till that crushes to gravelly loam, white (5Y 8/2) dry; massive; firm, hard, sticky and slightly plastic; few very fine irregular pores; 30 percent pebbles; pH is 9.8 in sodium fluoride; strongly acid.

Depth to dense glacial till is 20 to 40 inches. The profile is 15 to 35 percent rock fragments and is very strongly acid or strongly acid throughout.

The E horizon has hue of 7.5YR or 10YR, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry.

The Bs horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is gravelly loam or gravelly silt loam. Organic carbon stains are in some pedons.

The 2BC, 2C, and 2Cr horizons have hue of 2.5Y or 5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist or dry. They are gravelly loam or gravelly clay loam.

Formation of the Soils

Soil is the unconsolidated mineral and organic material on the Earth's surface that is capable of supporting plant life. Individual soils are natural bodies produced by soil forming processes that act on material accumulated by geologic processes.

The morphological features that identify an individual soil are the result of soil forming processes influenced by the physical and mineralogical composition of the parent material; the climate that prevailed during and since accumulation of the parent material; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time during which the soil forming processes have acted on the parent material. Climate and living organisms are active factors that influence soil formation. They influence the rate and kind of soil forming processes that slowly transform the chemical and physical properties of the parent material to produce a soil. Relief modifies the effects of the other factors by its influence on runoff, erosion, and microclimate.

The effects of the soil forming factors are so closely interrelated that in nature it is difficult to determine the effects of a single factor except in the rare situation where conditions of the other four are held relatively constant. Additionally, many processes involved in soil formation are not completely understood, and as a result there is no universal agreement on the precise role that a single soil forming factor plays in the formation of specific soil properties.

Parent Material

Parent material consists of unconsolidated surficial material, both mineral and organic and weathered or unweathered, from which soils are formed. Examples of parent material in this survey area are glacial till and outwash, river alluvium, and volcanic ash and cinders. Soils in this survey area have many properties, horizons, and soil landscape features that are inherited from the parent material. The origin, mode of deposition, and layering of the parent material are all important in identifying and describing these soils, in delineating phases of soils as map units, and in predicting behavior for various uses and levels of management.

Bedrock geology within the survey area is very complex in terms of origin, age, and rock sequences. The strong folding that characterizes the structure of the older sedimentary formations is complicated by the more recent uplift of the Cascade Range. The major drainage system of the Skagit River appears to have been determined by the older bedrock structures. The Cascade Range system, which dominates the present day highlands, was elevated during late Pliocene and early Pleistocene times.

During the final stages of the Cascadian uplift, and continuing through the Sumas Stade (about 10,000 years B.P.) of the Fraser Glaciation, the Puget Lowlands were invaded by continental ice sheets at least four times. During that time alpine glaciers intermittently occupied the upper reaches of the Cascade valleys (6). Effects of the older glacial advances and retreats have nearly all been obliterated by the Vashon Stade (14,000 to 18,000 years B.P.) of the most recent glacial period, referred to in this survey as the Fraser Glaciation. Alpine glaciers retreated well before the maximum advance of the Vashon ice sheet; consequently, most of the surficial soil forming material is deposits related to the advance and retreat of the Vashon ice. In addition, the soil landscapes are typical of glacial landforms and thus are either related to glacial deposits or to glacial scour of bedrock.

Glacial till originating directly in or under ice sheets includes hard. dense basal or lodgment till and loose, unsorted ablation till that may have been somewhat modified by meltwater. Soils that formed in part from this material occur as major components of map units on more than 250,000 acres in this survey area. This material ranges in elevation from near sea level to more than 4,000 feet and is in low to high precipitation zones and in mesic to cryic temperature regimes.

Soils that have dense till in the lower part of the profile commonly have properties associated with

restricted rooting depth and contrasting permeability in the solum and the C horizon. Other properties influenced by till are lithologic composition and particle sizes in the control section or the C horizon. For example. soils of the Cathcart series are identified by a till substratum derived primarily from sandstone or siltstone. The C horizon of these soils varies from gravelly loam and sandy loam derived from sandstone to clay loam derived from siltstone. Diobsud and Wollard soils have a Cr horizon that is high in content of phyllite. Sandun soils have a skeletal control section in which the coarse fragments are primarily dunite.

The denser tills are marked by the formation of weak duripans of iron and silica cementation at the ablation-basalt till interface. Soils with these features include those of the Elwell and Tokul series. Soils that formed in unconsolidated till, such as those of the Heisler and Sorensen series, are well drained and have an unrestricted rooting zone. The C horizon in these soils is friable and does not exhibit evidence of the silica or iron accumulation that is common in denser tills.

Glaciofluvial sediment transported and deposited by meltwater includes coarse, gravelly, and cobbly outwash along stream courses, sandy outwash on outwash plains, and fine sediment in glacial lakes. Soils that have these kinds of parent material have been mapped on about 90,000 acres in the survey area and are mostly below 1,600 feet in elevation and have a mesic temperature regime. Important properties of soils that formed in glaciofluvial sediment include particle size and shape, as well as contrasting layers in that part of the profile that is exposed to soil forming processes.

Floods of fast-moving meltwater deposited thick beds of coarse outwash along stream channels now occupied by the Sauk, Skagit, Suiattle, and Nooksack Rivers. Soils that formed in these deposits have a sandy-skeletal control section and substrata that range from interlayered sand and gravel to extremely cobbly outwash. Barneston, Jug, and Skykomish soils are associated with these deposits.

Deposits from slowly moving glacial streams consist of stratified sand and silt and can include minor amounts of water-rounded coarse fragments as well as an occasional glacial erratic. Birdsview and Indianola soils commonly are identified with these deposits. These soils have a sandy control section and have surface and subsurface horizons that show minimal effects of soil formation. They are classified as Entisols. In general, soils that formed in gravelly and cobbly outwash are excessively drained and are less productive than soils that formed in sandy and silty outwash.

Soils that formed in glaciolacustrine material include those of the Giles Variant and the Bow, Mundt, Saxon, Skipopa, and Thornton series. These soils are characterized by fine and fine-silty control sections. The fine textured soils, such as those of the Bow and Skipopa series, are very slow to drain internally and thus have a mottled subsoil produced by seasonal wetness. Most of these soils have a diagnostic subsurface horizon that exhibits a moderate grade of subangular blocky, blocky, or prismatic structure. As a group, these soils show more morphologic development in the solum than soils that formed in other glacial sediment. They are classified as Inceptisols.

Glacially scoured areas that are characterized by a thin veneer of glacial drift and colluvium over bedrock are identified on about 70,000 acres in the survey area. This material ranges from near sea level to more than 4,000 feet in elevation. Coarse material in the drift and colluvium includes granite, conglomerate, greenschist, argillite. phyllite, dunite, serpentine, and sandstone. Argillite and phyllite occur in areas of low to high precipitation and in mesic and frigid to cryic temperature regimes.

Properties common to this group of soils include R or Cr horizons that limit root penetration and soil formation. With the exception of the Cathcart series, these soils have a skeletal control section. The sandstone and siltstone from which the Cathcart soils are derived weather more rapidly than do other types of bedrock, and they produce loamy textures that include small amounts of rock fragments.

Guemes and Guemes Variant soils developed in material derived mainly from serpentine, which produces serpentinitic mineralogy in the control section. Another distinctive bedrock in this survey area is the dunite intrusion surfacing along the Howard Creek and Nooksack River valleys. Weathered dunite produces orange colored fragments and soil material that is high in magnesium and low in calcium, an essential plant nutrient, Jackman and Klawatti soils, which formed in this material, support a stunted stand of trees including lodgepole pine. Lodgepole pine also occurs on soils derived from serpentine on Cypress Island. The shrub understory in the forest on these soils is made up of plants not normally growing on the west side of the Cascades; these plants presumably have adapted to the special soil condition in this area (10).

Thin layers of volcanic ash from Cascade volcanoes and loess blankets of various thicknesses derived from

local outwash and flood plains overlie most of the drift and lithic material. At lower elevations this material is recognized as accumulated mixtures in the surface horizons. At higher elevations it occurs as discernible, discrete surficial layers that are primarily volcanic ash.

Surface horizons that have an appreciable amount of volcanic ash are silty. The ash imparts a characteristic smeariness to the soils. The silty texture increases their moisture holding capacity, which in turn increases the production and accumulation of biomass and organic cycling in the soil system. The greater amount of moisture available for growth is reflected in the thickness of the 0 horizon and the dark colored A horizon. In addition, higher moisture holding capacity and silty texture promote weathering, which results in a B horizon that has bright reddish colors.

The most recent parent material in the survey area is recent river alluvium. This material is well sorted and stratified, and it ranges from riverwash on stream floodways to fine-silty, still water sediment in estuaries. Geologic erosion of the land surface by ice and water and transport of the debris by streams is a continuing process. At present all major streams heading in the Cascades are fed by active alpine glaciers that unload varying amounts of rock flour during the annual melting cycle. Consequently. the Skagit River continues to flood estuarine areas with sand and silt, thereby creating an ever-widening delta system that now links the mainland to offshore islands. Together, elevated alluvial terraces, low flood plains, and areas of deltaic sediment cover about 120,000 acres of this survey area, mostly below 400 feet in elevation. These recent deposits have created some of the most productive soils for specialty crops in Washington.

As a group, soils that formed in alluvium display few diagnostic properties beyond those attributable to alluvial parent material. Surface horizons have dark colors as a result of the production and accumulation of organic matter. The Mt. Vernon soils are the only soils in this group that have a mollic surface horizon. The Minkler, Nargar, and Wickersham soils have an ochric horizon, but the rest of the soils in this group are Entisols that do not have distinctive properties. The subsurface horizons of these soils have the colors of the parent material or show some degree of mottling caused by poor drainage.

Soils form in organic material such as peat, as well as in mineral matter. This occurs when plant and animal remains accumulate in standing water. Organic material does not decompose under anaerobic conditions, and it may accumulate to a considerable depth. Soils that formed in deposits of peat are wet and very acidic, and they characteristically support plant communities composed of sedges, tules, cranberry, mosses, and Labrador tea. Small deposits of organic material are in depressional areas throughout the survey area. Most of the soils in these areas are mapped as Mukilteo soils.

Climate

Climate directly influences chemical, physical, and biological processes that produce morphological properties in soil profiles. Components of climate that are important include kind, amount, and intensity of precipitation; annual, seasonal, and daily temperature averages and extremes; and length of the growing season.

In general, the climate in the survey area is characterized by cool, dry summers and mild, moist winters. The mean annual temperature ranges from 38 degrees F in the mountains to 50 degrees near the coast. The growing season ranges from about 220 days near the coast to less than 90 days in the high Cascades. Three of the soil temperature regimes used in Soil Taxonomy (18) are recognized in the survey area; (1) cryic, where the average annual soil temperature is 32 to 47 degrees and the average soil temperature in summer is less than 47 degrees; (2) mesic, where the average annual soil temperature is 47 to 59 degrees; and (3) frigid intermediate, between cryic and mesic, where the average annual soil temperature is 32 to 47 degrees and the average soil temperature in summer is more than 47 degrees.

Annual precipitation ranges from 18 inches near the coast to more than 100 inches at the crest of the Cascades. Most of the precipitation falls from late in fall to late in spring. In areas of the mesic soils and the warmer phases of the frigid soils, most precipitation occurs as rain or fog drip; in areas of the cryic soils and the colder phases of the frigid soils, most precipitation falls as snow. At elevations above 2,000 feet, snow often remains on the ground from November to March.

Soils in areas where the snow cover remains on the ground over winter develop a thick organic layer above the mineral soil. Although the growing season is shorter and litter fall is less than in areas that have little snow cover, the cooler temperatures and higher precipitation slow decomposition and inhibit biological activity. As a result, the organic matter accumulates on the surface and the boundary between the 0 horizon and the underlying mineral surface layer is abrupt. Roots concentrate in the humidified part of these layers,

where most of the nutrient supply of these soils accumulates.

In areas where crystalline clay is present in the parent material and the annual precipitation is about 25 to 30 inches. the Bow and Guemes soils formed. These soils have morphological properties resulting from the translocation of clay. In this rainfall zone, there is sufficient moisture and enough wetting and drying cycles to move clay particles from the E horizon into the Bt horizon below, where the translocated clay appears as flows and films in pores and on ped faces.

The most striking example of the influence of climate in soil formation in this survey area is illustrated in the degree of development of master horizons in a climosequence of soils that includes; Squires soils (mesic Andic Xerochrepts); Sorensen soils (frigid Andic Xerochrepts); Wollard soils (Typic Cryorthods); and Diobsud soils (Humic Cryorthods). These soils formed in till and colluvium derived mostly from phyllite with an admixture of loess and volcanic ash on glaciated mountainous slopes that range from 3 to 65 percent. The climate under which these soils formed ranges from one characterized by an average annual precipitation of 55 inches, an average annual air temperature of 48 degrees, and an average of 160 to 200 frost-free days per season for the Squires soils to 90 inches average annual precipitation, 38 degrees average annual air temperature. and 90 to 110 frost-free days per season for the Diobsud soils.

The 0 horizon of the Sorensen and Squires soils commonly ranges from 2 to 4 inches in thickness, but this horizon commonly is 4 to 10 inches thick on the colder and wetter soils of the Diobsud and Wollard soils. This is because the rate of organic matter decomposition decreases greatly as temperature decreases. Soils that have a thicker 0 horizon produce more organic acids. These acids, along with high precipitation, cause iron and alluvium to be leached from the mineral surface layer to form a light colored E horizon. The E horizon is intermittent; where present, it is as much as 1 inch thick in the Squires and Sorensen soils and becomes well developed and 2 to 5 inches thick in the Wollard and Diobsud soils. Iron, alluvium, and organic matter leached from the 0 and E horizons accumulate in the B horizon of these soils. Sorensen and Squires soils have only enough iron and alluvium added to the B horizon to change color and structure to form a cambic horizon, but it does not meet the chemical requirements of a spodic horizon. The Diobsud and Wollard soils have a B horizon that meets the chemical requirements of a spodic horizon.

Plants and Animals

Plants have a greater effect on the soils of the survey area than do any other living organisms except man. Coniferous forests dominated the vegetation during presettlement times. Forests influence soil development by stabilizing the mineral soil surface under the forest floor and by the presence of a canopy that shields the soil from the impact of rain and surface runoff.

In addition to physical stability, forests provide a living web of roots, stems, and leaves that incorporate and retain nutrients in the soil. As weathering of the mineral soil proceeds, plants use the released nutrients. Leaves, branches, and entire trees die and fall to the ground, and a host of insects, snails. grubs, slugs, worms, bacteria, and fungi set upon the debris to decompose it into humus and incorporate it into the soil. This process is referred to as the nutrient cycle, and it results in a pool of nutrients in the soil that reaches a steady state with time. Much of this nutrient pool is held in the living plants and in the forest floor. The organic residue that is incorporated into the mineral soil aids in the formation of soil structure, thus increasing the permeability of the soil to water and increasing the water retention and nutrient holding capacity of the soil. The presence of organic matter in the soil is manifested in the dark brown and reddish brown to black colors of the surface layer. Where vegetation has been present for a long time, the influences of plants and animals on the soils in the survey area have reached a steady state.

Man's influence on the soils in the survey area has consisted primarily of the removal of native vegetation and the cultivation of crops. Timber harvesting has resulted in removal of the original vegetation, which commonly causes changes in site conditions in terms of soil disturbance and microclimate.

Occasionally, man's influence on the soils is all too apparent. Thornton soils, which formed in fine-silty lacustrine sediment derived from talc, are an example. The small, uniformly sized particles in these soils produce very small pore spaces that allow water to infiltrate and move through the soil profile. The native forest on these soils provided a thick canopy that intercepted much of the 45 inches of precipitation that fell, and most of the rest was transpired by the trees. Thornton soils under forest are free of surface water. Removal of the trees allows all of the precipitation to reach the soil, and allows more water to stay in the soil, since less moisture is transpired if trees are not

present. Thornton soils that have been cleared now have standing water on the surface for much of spring and the early part of summer.

Mt. Vernon soils on the Skagit Flats were the first to be cleared for cultivation by white settlers in the 19th century. The annual additions of manure and crop residue to the soils, and their use as pasture during the time when dairying was common, have resulted in the formation of a dark colored surface layer that qualifies as a mollic epipedon. Changes in vegetation and additions of organic matter have resulted in a significant change in the morphology and taxonomic classification of the Mt. Vernon soils. A diagnostic surface layer can be lost through mixing or erosion, such as where timber is harvested on steep slopes.

Relief

Relief can be thought of as elevation and aspect differences on a geomorphic surface or soil landscape. Relief is highly variable in the survey area, ranging from areas of little relief on the flat delta of the Skagit River to very rugged relief in areas where the elevation is more than 4,500 feet.

Relief affects climate in this area in several ways. Snow cover and precipitation increase and temperature and length of the frost-free season decrease as elevation increases in the mountains. Aspect, the direction a slope faces, results in variations in soil temperature and moisture and in the amount of sunlight that is received. On the south-facing slopes of a mountain the elevation of the frigid-cryic temperature boundary may be as much as 2,300 feet, but on the north-facing slopes of the same mountain this temperature line may be as low as 1,800 feet.

Relief indirectly influences soil moisture regimes by influencing the amount of water that infiltrates the soil. As slope increases, more water runs off and less is available to enter the soil. Relief also influences moisture conditions in soils that have a layer that restricts percolation, such as a dense till layer or a clayey subsoil. Skipopa soils that have slopes of 0 to 8 percent have a clay substratum. Water from rainfall moving into the Skipopa soils cannot percolate rapidly enough through the clay substratum to drain the profile. As a result, the Skipopa soils have a perched water table most of the time in spring and are somewhat poorly drained. Hoogdal soils that have slopes of 8 to 60 percent also have a clay substratum, but these soils are moderately well drained because the steeper slope allows the perched water to move laterally downhill and out of the soil.

Minkler soils are on terraces where water accumulates after moving downslope from adjacent higher land surfaces. Minkler soils are silty or loamy in texture and have no restrictive subsoil to impede water movement through the profile; because of fine stratification and the large volume of water accumulating on them, however, they are only moderately well drained and have mottles throughout the profile.

On the steeper slopes of the mountainous regions, soil creep, mass movement, surface erosion, and low water infiltration combine to limit soil horizon development. A and B horizons are continually being mixed as mass wasting keeps pace with soil development processes. These conditions result in soils that are young, or immature, in relation to soils on more stable surfaces. Large areas of these soils are mapped in this survey area and are identified by subgroup taxa. These landforms are termed erosional landforms.

Time

Time is necessary for development of a soil. Since processes of soil development are slow, long periods of time are usually required for the development of distinct horizons. The combined effects of the other soil forming factors, especially climate, greatly influence the rate of soil formation. In areas of greater precipitation and higher temperatures, soil development generally proceeds faster than in areas of similar parent material where there is less precipitation or more moderate temperatures. The previously mentioned examples of formation of spodic horizons versus cambic horizons apply.

Most of the survey area is composed of soils that formed from glacially deposited material; therefore, most soils in the area are similar in age and in time sequence of soil development. Some landforms, however, are younger than others. In addition to the erosional surfaces mentioned under relief, alluvial landforms such as flood plains, alluvial fans, and deltas are of recent origin. These are landforms where soil material is continually being added. Skagit soils, which formed in silty alluvium from periodic flooding by the Skagit River, are so young that no subsoil has formed. The Wiseman soils are on alluvial fans at the base of mountainsides and are also considered to be young. Wiseman soils formed in the gravel and sand carried downslope by spring runoff. Skagit and Wiseman soils are classified as Entisols.

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Glossary

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.

Alluvial fan. The fanlike deposit of a stream where it issues from a gorge upon a plain or of a tributary stream near or at its junction with its main stream.

Alluvial terrace. A stream or river terrace, commonly flat or nearly so, produced by renewed erosion of the flood plain or valley floor by stream action or by the covering of a present low terrace with alluvium.

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.

Ash (volcanic). See volcanic ash.

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

Very low	0 to 2.0
Low	2.0 to 3.75
Moderate	3.75 to 5.0
Moderately high	5.0 to 7.5
High	More than 7.5

Avalanche track. The central channellike corridor along which an avalanche has moved; it may take the form of an open path in a forest, with bent and broken trees, or of an eroded surface marked by pits, scratches, and grooves.

Back slope. The geomorphic component that forms the steepest inclined surface and principal element of many hillsides. Back slopes in profile are commonly steep, are linear, and may or may not include cliff segments.

Basal area. The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

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.

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.

Breast height. An average height of 4 1/2 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Break. The steep to very steep broken land at the border of an upland summit that is dissected by a ravine.

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.

Channery soil. A soil that is, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches across along the longest axis. A single piece is called a channer. Very channery soil material is 35 to 60 percent of these fragments, and extremely channery soil material is more than 60 percent.

Cirque. Semicircular, concave, bowllike area that has

steep faces primarily resulting from abrasion by glacial ice and snow.

Cirque headwall. A steep slope at the head of a valley, especially the rock cliff area in back of a cirque.

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.

Climax plant community. The plant community on a given site that will be established if present environmental conditions continue to prevail and the site is properly managed.

Coarse fragments. Mineral or rock particles larger than 2 millimeters in diameter.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material. Material that is 15 to 35 percent, by volume. rounded or partially rounded rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Very cobbly soil material is 35 to 60 percent of these rock fragments, and extremely cobbly soil material is more than 60 percent.

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 or miscellaneous areas 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 or miscellaneous areas are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes. shapes. and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conglomerate. A coarse grained, clastic rock composed of rounded to subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer material. Conglomerate is the consolidated equivalent of gravel.

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.-Readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.-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 (particle-size 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.

Crop residue management. Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cropping system. Growing crops using a planned system of rotation and management practices.

Culmination of the mean annual increment (CMAI). 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.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Cut slope. The uphill slope left after earth-moving equipment has excavated or cut into a hillside to make a roadbed.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

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.-These soils have very high and high hydraulic conductivity and low water holding capacity. They are not suited to crop production unless irrigated.

Somewhat excessively drained.-These soils have high hydraulic conductivity and low water holding capacity. Without irrigation, only a narrow range of crops can be grown and yields are low.

Well drained.-These soils have intermediate water holding capacity. They retain optimum amounts of moisture, but they are not wet close enough to the surface or long enough during the growing season to adversely affect yields.

Moderately well drained.-These soils are wet close enough to the surface or long enough that planting or harvesting operations or yields of some field crops are adversely affected unless artificial drainage is provided. Moderately well drained soils commonly have a layer with low hydraulic conductivity, a wet layer relatively high in the profile. additions of water by seepage, or some combination of these.

Somewhat poorly drained.-These soils are wet close enough to the surface or long enough that planting or harvesting operations or crop growth is markedly restricted unless artificial drainage is provided. Somewhat poorly drained soils commonly have a layer with low hydraulic conductivity, a wet layer high in the profile, additions of water through seepage, or a combination of these.

Poorly drained.-These soils commonly are so wet at or near the surface during a considerable part of the year that field crops cannot be grown under natural conditions. Poorly drained conditions are caused by a saturated zone, a layer with low hydraulic conductivity, seepage, or a combination of these.

Very poorly drained.-These soils are wet to the surface most of the time. They are wet enough to prevent the growth of important crops (except rice) unless artificially drained.

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.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and produced by erosion or faulting. Synonym; scarp.

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.

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.

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 commonly is on the downhill side of the road.

Fine textured soil. Sandy clay, silty clay, and clay.

Firebreak. Area cleared of flammable material to stop or help 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.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foothill. A steeply sloping upland that has relief of as much as 1,000 feet (or 300 meters) and fringes a mountain range or high-plateau escarpment.

Foot slope. The inclined surface at the base of a hill.

Forest cover. All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

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.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard rock. Rock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

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.

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.

E horizon.-The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

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 overlying soil material. 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 number 2 precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but it 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.

Igneous rock. Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock. Examples are andesite. basalt, and granite.

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.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

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.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

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.

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.

Mean annual increment. The average yearly volume growth of a stand of trees from the year or origin to the age under consideration.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

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).

Mountain. A natural elevation of the land surface, rising more than 1,000 feet above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides and considerable bare-rock surface. A mountain can occur as a single, isolated mass or in a group forming a chain or range.

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 in hue of 10YR, value of 6, and chroma of 4.

Natural reforestation. Reforestation resulting from seedlings that become established from seed disseminated by nearby trees. The expected period of time it takes for an area to become naturally reforested is described by the terms *readily,* meaning that seedlings can be expected to occupy the area in 2 to 5 years; *periodically,* in 5 to 10 years; and *infrequently,* in 10 to 20 years.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash terrace. A broad, flat to undulating plain bordering a stream, river, lake, bay, sound, or ocean and commonly made up of deposits from melting glaciers.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule. a prism, or a block.

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 0.2 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.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

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.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Pumice. Porous tephra fragments (more than 2 millimeters in size) ejected during volcanic activity. They are light weight and commonly are light in color. Pumice fragments will crush under a load.

Pyroclastic. The Greek word for "fire-broken," referring to fragmented volcanic rock thrown out during an eruption.

Pyroclastic flow. A volcanic flow of hot gas and fragmental material (pyroclastic); it is composed of either pumice or lithic (nonvesicular) debris, or a mixture of both.

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-

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 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.

Rill. A steep-sided channel resulting from accelerated erosion. A rill generally is a few inches deep and not wide enough to be an obstacle to farm machinery.

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.

Root zone. The part of the soil that can be penetrated by plant roots.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts 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 groundwater 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.

Saprolite (soil science). Unconsolidated residual material underlying the soil and grading to hard bedrock below.

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 (in tables). 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.

Shoulder slope. The uppermost surface at the top of a foothill slope or mountainside. It is the transition zone from a back slope to the ridgetop. The surface of a shoulder slope commonly is convex.

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.

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 the range of ages on soils that differ in productivity. Each level is represented by a curve. The basis of the curves is 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 basis of the curves is the height of dominant and codominant trees that are 100 years old or are 100 years old at breast height.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Skid trails. The paths left by the skidded logs and the bulldozer tractor used to pull them.

Skidding. A method of moving felled trees to a nearby central area.

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. In this survey the following slope classes are recognized-

Nearly level	0 to 3 percent
Gently sloping	3 to 8 percent
Moderately sloping	8 to 15 percent
Moderately steep	15 to 30 percent
Steep	30 to 65 percent
Very steep	65 to 80 percent
Extremely steep	80 percent or more

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

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.

Soft rock. Rock that can be excavated with trenching machines, backhoes, small rippers, and other

equipment commonly used in construction.

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 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

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, E, 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 if rounded or 6 to 15 inches (15 to 38 centimeters) in length if flat.

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 grain* (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 E 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."

Talus. Rock fragments of any size or shape, commonly coarse and angular, derived from and lying at the base of a cliff or very steep, rock slope. The accumulated mass of such loose, broken rock formed chiefly by falling, rolling, or sliding.

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.

Tephra. Fragmental volcanic debris that is transported from the crater through the air. Does not denote properties of composition, vesicularity, or grain size.

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 generally is 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.

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 earths 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.

Windthrow. The action of uprooting and tipping over trees by the wind.

Yarding. A logging term meaning to move a log from the area in which it was cut to a landing or loading area.

Yarding paths. The paths left from cable yarded logs as they are pulled uphill or downhill to a nearby central area.

Yield (woodland). The volume of wood fiber from harvested trees taken from a certain unit of area. Usually measured in board feet or cubic feet per acre.