

This is a scanned version of the text of the original Soil Survey report of Whatcom County Area, Washington issued May 1992. Original tables and maps were deleted. There may be references in the text that refer to a table that is not in this document.

Updated tables were generated from the NRCS National Soil Information System (NASIS). The soil map data has been digitized and may include some updated information. These are available from <http://soildatamart.nrcs.usda.gov>.

Please contact the State Soil Scientist, Natural Resources Conservation Service (formerly Soil Conservation Service) for additional information

## **Foreword**

This soil survey contains information that can be used in land-planning programs in the survey 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, 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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# Soil Survey of Whatcom County Area, Washington

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The survey area is in the northwest corner of Washington (fig. 1). It has an area of about 809 square miles, or 518,135 acres. The population of the county in 1980 was 106,701. Bellingham, the county seat, had a population of 45,794. It is in the southwestern part of the survey area.

The survey area is bounded on the west by the Strait of Georgia, on the south by Skagit County, on the east by the Mount Baker-Snoqualmie National Forest, and on the north by Canada. A few privately owned areas are interspersed in the national forest near Baker Lake. The survey area ranges from 18 to 34 miles from east to west and is about 25 miles from north to south. Point Roberts is located on a peninsula 10 miles west of the main part of the survey area. It is connected to the rest of the survey area by roads that run through Canada.

The northwestern half of the survey area is nearly level to rolling. It includes flood plains, outwash terraces, and glaciomarine drift plains at elevations of sea level to 300 feet above sea level. The southeastern part is dominantly steep and mountainous, except for the flood plains along the three forks of the Nooksack River. Dairy farming, hay and pasture, and forestry are the main economic enterprises in the survey area.

Soil scientists have identified about 100 different kinds of soil in the survey area. The soils have a wide range of texture, natural drainage, and other characteristics. The soils along the major drainageways

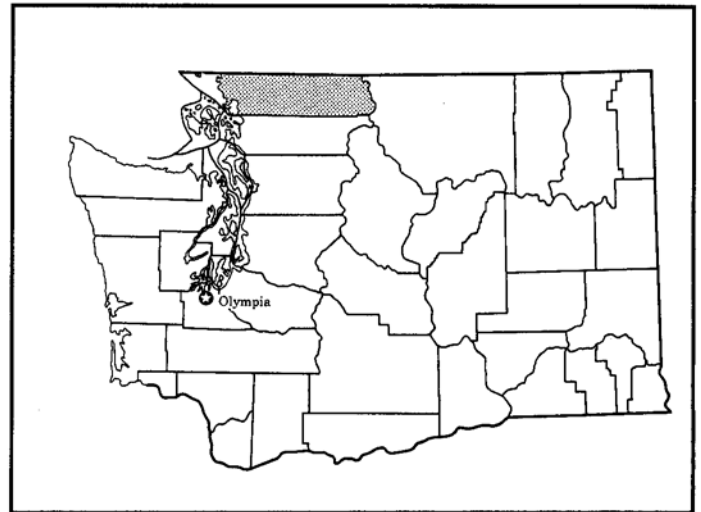


Figure 1.-Location of Whatcom County In Washington.

are suited to cropland, hay, and pasture. Wetness and the hazard of flooding are the main management concerns. The soils on outwash terraces are suited to cropland, hay and pasture, and woodland. A moderate available water capacity and a high water table are the main limitations. Extensive tile drainage has made the soils on the outwash terraces and flood plains well

suited to field crops. Soils on glaciomarine drift plains and lacustrine terraces are used for hay and pasture, cropland, or woodland. Wetness and slow permeability are the main limitations. Soils on foothills and mountains are suited to woodland. The main limitations are the slope and wetness.

An older survey, "Soil Survey of Whatcom County, Washington," was published in 1953 (34). This earlier survey covers a part of the present survey. The present survey, however, updates the earlier survey and provides additional information and larger maps that show the soils in greater detail.

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, intensity of mapping, or the extent of soils within the survey area.

## General Nature of the Survey Area

This section gives general information about the Whatcom County area. It describes history and development; climate; and physiology, relief, and drainage.

## History and Development

Whatcom County was established by the legislature of the territory on March 9, 1854. The county was named for a Nooksack Indian chief. Whatcom was also the name of the first town on Bellingham Bay and was the predecessor of the city of Bellingham.

Agriculture and forestry have been the major industries in Whatcom County since settlement began. The county supports more dairy cattle than any other county in the Pacific Northwest. Hay, pasture, truck vegetables, berries, and seed potatoes are important crops. Fishing, recreation, and mining also are major contributors to the economy. The county's proximity to Canada increases its market for goods and services.

## Climate

Prepared 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 the higher elevations. At the lower elevations freezing temperatures generally occur under the influence of dry air masses. During summer, rainfall is extremely light, so crops growing actively during this period need

irrigation. Often several weeks pass without precipitation. During the rest of the year, rains are frequent, especially in late fall and winter.

In most winters one or two storms contain strong and sometimes damaging winds, and in some years the accompanying heavy rains cause serious flooding. Ice-laden, northeast winds moving down the valley of the Fraser River are particularly damaging. In some years, either during winter or summer, a large invasion of a continental air mass from the east causes abnormal temperatures. As a result, several consecutive days are well below freezing in winter or a week or longer is sweltering in summer.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Blaine, Glacier, Bellingham, and Clearbrook, Washington. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperatures at Blaine, Glacier, Bellingham, and Clearbrook are 39, 34, 39, and 38 degrees F, respectively. The average daily minimum temperature is 33 degrees at Blaine and Bellingham, 28 degrees at Glacier, and 32 degrees at Clearbrook. The lowest temperature on record, which occurred at Glacier, is -12 degrees. In summer, the average temperature is 60 degrees at Blaine and 61 degrees at Glacier, Bellingham, and Clearbrook. The average daily maximum temperature is about 73 degrees at all four locations. The highest recorded temperature, which occurred at Clearbrook, 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 (41 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 41 inches at Blaine, 67 inches at Glacier, 36 inches at Bellingham, and 46 inches at Clearbrook. Of this, 30 percent usually falls in April through September. The growing season for most crops falls within this period. The heaviest 1-day rainfall during the period of record was 4.65 inches at Glacier on December 14, 1959. Thunderstorms occur on about 6 days each year.

The average seasonal snowfall is 12 to 14 inches at Blaine and Bellingham, 48 inches at Glacier, and 19 inches at Clearbrook. During the period of record, the greatest snow depth in the survey area at any one time was 37 inches. On the average, 2 or fewer days at Blaine, Bellingham, and Clearbrook and 7 days at Glacier have at least 1 inch of snow on the ground. The

number of such days varies from year to year.

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

## **Physiography, Relief, and Drainage**

The survey area can be divided into two distinct physiographic regions. These regions are the Cascade Range and the Whatcom Basin (14).

The Cascade Range rises abruptly from the floor of the Whatcom Basin, culminating in the snowfields and glaciers of Mount Baker, Mount Shuksan, and the Twin Sisters Mountain. The topography is extremely rugged. It consists of pre-Tertiary metamorphic and Tertiary sedimentary rocks with a mantle that is dominantly Vashon till and some outwash (11). The mountains in the survey area rise to about 5,500 feet. The higher elevations have young, narrow, steep-sided valleys, which become broader and mantled with alluvium and glacial drift as they descend to the Whatcom Basin.

The Whatcom Basin ranges in elevation from sea level to about 600 feet above sea level. It lies entirely within the Puget Trough of the Pacific Border physiographic province. The low topography of the Basin is a result of several glaciations, marine submergences and rebounds, postglacial fluvial action, and eolian deposition. It consists of hummocky glaciomarine drift plains; nearly level glaciofluvial terraces that have large bogs; and rolling, drift-capped uplands overlooking the broad flood plain of the Nooksack River.

The Whatcom Basin consists of seven significant upland plateau areas and three lowland terraces (14, 46). The seven upland provinces are the Birch Point Upland, a small peninsular area southwest of Blaine; the Boundary Upland, east of Blaine extending across the international boundary into Canada; the Mountain View Upland, west of Ferndale; the King Mountain Upland, extending north from Bellingham to the Nooksack River Valley; the Lummi Peninsula, between Lummi Bay and Bellingham Bay; Lummi Island; and Point Roberts, a small peninsular projection of Canada. The three lowland areas are the Custer Trough, which trends northwest to Drayton Harbor and Birch Bay; the Lynden Terrace, which extends westward from the Sumas River Valley to the Boundary Upland and southward to the Nooksack and Custer Trough bottom land; and the flood plains along the Nooksack and Sumas Rivers.

The Birch Point Upland, which is about 4 square miles in size, is bounded on three sides by steep cliffs. Its maximum elevation is about 265 feet.

The Boundary Upland is about 10 miles long and 3 miles wide. It reaches an elevation of nearly 500 feet. The Boundary and Birch Point Uplands are till and glaciomarine drift that have a mantle of sand and gravel more than 3 feet thick.

The Mountain View Upland embraces an area of about 42 square miles. It reaches an elevation of 385 feet. The western border of the upland consists of steep sea cliffs, which drop to the Georgia Strait. The upland is bordered on the north by the Custer Trough and on the east and south by the flood plains along the Nooksack and Lummi Rivers. It is dominantly impermeable glaciomarine drift that has a veneer of sand and gravel.

The King Mountain Upland rises to the south from the Nooksack River Valley. It reaches a maximum elevation of about 500 feet and then grades into the slopes of the Cascade foothills. It is predominantly glaciomarine drift, although outcrops of Tertiary sandstone protrude through the unconsolidated materials.

The Lummi Peninsula was formerly an island. The connection between the island and the mainland was affected by deposition of fine-grained deltaic deposits, probably from the Nooksack River. The peninsula is a low, rolling surface, which is dominantly impermeable glaciomarine drift that has a veneer of sand and gravel in places. The maximum elevation is about 170 feet. No perennial streams are on the peninsula.

Lummi Island is a northwest-southeast trending island about 9 miles long and 1.5 miles wide. It lies southwest of Lummi Peninsula. The northwestern part of the island is a low, rolling glaciomarine and till-capped surface that has a mantle of sand and gravel more than 3 feet thick. The southeastern part consists of metamorphic rock. It is steeply sloping and reaches a maximum elevation of 1,665 feet. The average elevation is about 150 feet. No perennial streams are on the island.

Point Roberts, which is about 5 square miles in size, is separated from the rest of the survey area by land that is part of Canada. Like northern Lummi Island, it is a low, rolling glaciomarine and till-capped surface and has no perennial streams. The northeastern part is mantled with sand and gravel more than 3 feet thick. The maximum elevation is 235 feet.

The Custer Trough and the Lynden Terrace have a maximum elevation of 200 feet. They consist of recessional outwash material of the Fraser glaciations and glacial materials reworked by the Nooksack River. Within these two units are silt and clay deposits left by

the impoundment of glacial lakes.

The flood plains along the Nooksack and Sumas Rivers consist of stratified alluvial material. They are mainly below an elevation of 50 feet. The flood plain along the South Fork of the Nooksack River reaches an elevation of about 300 feet. The Sumas River is an underfit stream. It occupies a valley that was used by the Fraser River during the Pleistocene. At that time the Fraser River flowed south as a result of ice blocks to the north.

The drainage of the survey area is dominantly through the Nooksack River and its tributaries. A few streams, however, flow directly into Georgia Strait and a small area drains through the Samish River to Skagit County and through the Sumas River to Canada (46). The headwaters of the North, Middle, and South Forks of the Nooksack River are on Mount Shuksan, Mount Baker, and the Twin Sisters Mountain, respectively. The forks join near Deming to form the main channel of the river. Relative relief within the basins of the three forks is 7,000 to more than 10,000 feet. Genetically, the three forks are consequent streams. Their courses are dictated by topography and slope rather than by geologic structure or faulting.

Seven streams course the glacial drift of the Whatcom Basin and are maintained primarily by ground-water discharge from the glacial material. These are Bertrand, Tenmile, Fishtrap, Dakota, California, Terrell, and Silver Creeks. Squalicum and Anderson Creeks also are major tributaries of the Nooksack River.

## How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; 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 biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By

observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil 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-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 soil 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. 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 (43). 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 a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret 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 are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are 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 are 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 predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure 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.

## **Map Unit Composition**

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. 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 soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns 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 (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils 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 onsite investigation is needed to plan for intensive uses in small areas.

# 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, it consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in another but in a different pattern.

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

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

## **Soil Descriptions**

### **Soils on Flood Plains, Terraces, Deltas, and Tidal Flats**

These soils make up about 10 percent of the survey area. They are level and nearly level. The native vegetation is mainly trees and shrubs. Elevation is at or near sea level to 300 feet above sea level. The average annual precipitation is 30 to 60 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 160 to 210 days.

These soils are very deep and are very poorly drained to well drained. In many areas they have been artificially drained. They formed in alluvium.

These soils are used mainly as hayland and pasture or as cropland.

#### **1. Mt. Vernon-Puyallup**

*Very deep, moderately well drained and well drained, nearly level soils; on river terraces and flood plains*

This map unit is in the western part of the survey area, along the Nooksack River and its tributaries.

Slope is 0 to 2 percent. The native vegetation is mainly conifers and shrubs. Elevation is 10 to 300 feet. The average annual precipitation is 30 to 60 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 160 to 210 days.

This unit makes up about 5 percent of the survey area. It is about 41 percent Mt. Vernon soils, 21 percent Puyallup soils, and 38 percent soils of minor extent.

Mt. Vernon soils are moderately well drained. They formed in alluvium with an admixture of volcanic ash in the upper part. Typically, the surface layer is fine sandy loam. The underlying material is stratified, mottled fine sandy loam, very fine sandy loam, and sand.

Puyallup soils are well drained. They formed in alluvium. Typically, the surface layer is fine sandy loam. The next layer is loam and fine sandy loam. The underlying material is sand.

Of minor extent in this unit are the somewhat excessively drained Pilchuck and Snoqualmie soils and Riverwash along the river channels, the somewhat excessively drained Kline soils on alluvial fans, and the well drained Larush soils on low river terraces along the South and Middle Forks of the Nooksack River.

This unit is used as hayland and pasture or as cropland. The main limitations in the areas used for hay and pasture or for crops are the seasonal high water table in the Mt. Vernon soils and a moderate available water capacity in the Puyallup soils. The main limitations affecting homesite development are the hazard of flooding on both soils and the seasonal high water table in the Mt. Vernon soils. The main limitations on sites for septic tank absorption fields are the seasonal high water table in the Mt. Vernon soils and a poor filtering capacity in the substratum of the Puyallup soils.

#### **2. Eliza-Tacoma**

*Very deep, very poorly drained, level soils that generally have been artificially drained; on flood plains, deltas, and tidal flats*

This map unit is in the southwestern part of the survey area, along the Nooksack and Lummi Rivers.

Slope is 0 to 1 percent. The native vegetation is mainly conifers and shrubs. Elevation is at or near sea level to 20 feet above sea level. The average annual precipitation is 30 to 40 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 160 to 210 days.

This unit makes up about 1 percent of the survey area. It is about 70 percent Eliza soils, 25 percent Tacoma soils, and 5 percent soils of minor extent.

Eliza soils are very poorly drained but in most areas have been artificially drained. They formed in alluvium. Typically, the surface layer is silt loam. The upper part of the underlying material is mottled fine sandy loam. The lower part is stratified, mottled silt loam and fine sandy loam.

Tacoma soils are very poorly drained but in most areas have been artificially drained. They formed in alluvium. Typically, the surface layer is mottled silt loam. The upper part of the underlying material also is mottled silt loam. The lower part is mottled very fine sandy loam.

Of minor extent in this unit are the somewhat excessively drained Neptune soils on marine terraces.

This unit is used mainly as hayland and pasture or as cropland. Undrained soils are used as woodland or for wildlife habitat.

The main limitations in the areas used for hay and pasture or for crops are the seasonal high water table, the salt influence, and the moderately slow permeability in the Tacoma soils. The main limitations affecting homesite development and septic tank absorption fields are the hazard of flooding and the seasonal high water table in both soils. The main limitations affecting timber harvesting are the hazard of flooding and the muddiness caused by seasonal wetness.

### **3. Briscot-Oridia**

*Very deep, poorly drained, nearly level soils that have been artificially drained; on flood plains*

This map unit is in the western part of the survey area, along the Nooksack River and its tributaries. Slope is 0 to 2 percent. The native vegetation is mainly conifers and shrubs. Elevation is 20 to 300 feet. The average annual precipitation is 35 to 55 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 160 to 190 days.

This unit makes up about 4 percent of the survey area. It is about 37 percent Briscot soils, 25 percent Oridia soils, and 38 percent soils of minor extent.

Briscot soils formed in alluvium. Typically, the surface layer is silt loam. The underlying material is mottled silt loam, very fine sandy loam, fine sandy loam, and fine sand.

Oridia soils formed in alluvium. Typically, the surface layer is silt loam. The upper part of the underlying material is mottled silt loam. The lower part is mottled very fine sandy loam.

Of minor extent in this unit are the poorly drained Bellingham soils and Puget, Snohomish, and Sumas soils that have been drained.

This unit is used as hayland and pasture or as cropland (fig. 2). The main limitation in the areas used for hay and pasture or for crops is the seasonal high water table. The main limitations affecting homesite development and septic tank absorption fields are the hazard of flooding and the seasonal high water table.

### **Soils on Outwash Terraces, Moraines, and Till Plains**

These soils make up about 22 percent of the survey area. They are level to very steep. The native vegetation is mainly trees and shrubs. Elevation is at or near sea level to 1,200 feet above sea level. The average annual precipitation is 35 to 75 inches, the average air temperature is 45 to 52 degrees F, and the average frost-free season is 150 to 210 days.

These soils are deep and very deep and are very poorly drained to somewhat excessively drained. Most of the very poorly drained areas have been artificially drained. The soils formed dominantly in alluvium, loess, volcanic ash, organic deposits, glacial outwash, and glaciofluvial deposits.

These soils are used mainly as hayland and pasture, as cropland, or as woodland. They also are used as sites for homes and as a source of aggregate.

### **4. Kickerville-Barneston-Everett**

*Very deep and deep, well drained and somewhat excessively drained, level to very steep soils; on outwash terraces and moraines*

This map unit is on outwash terraces and terrace escarpments throughout the survey area. Slope is 0 to 60 percent. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 1,200 feet. The average annual precipitation is 35 to 75 inches, the average annual air temperature is 45 to 52 degrees F, and the average frost-free season is 150 to 210 days.

This unit makes up about 9 percent of the survey area. It is about 27 percent Kickerville soils, 24 percent Barneston soils, 19 percent Everett soils, and 30 percent soils of minor extent.

Kickerville soils are very deep and well drained. They formed in a mixture of loess and volcanic ash over glacial outwash. They are on outwash terraces. Typically, the surface layer is silt loam. The upper part of the subsoil also is silt loam, and the lower part is very gravelly loam. The substratum is extremely



**Figure 2.-A pastured area of the Briscot-Ordia general soil map unit is in the foreground. The wooded foothills in the background are in the Vanzandt-Squires and Montborne-Rinker general soil map units.**

gravelly sand and very gravelly sand.

Barneston soils are very deep and somewhat excessively drained. They formed in a mixture of loess and volcanic ash over glacial outwash. They are on outwash terraces and terrace escarpments. Typically, the surface layer is gravelly loam. The subsoil is very gravelly loam. The substratum is extremely gravelly sand.

Everett soils are very deep and deep and are somewhat excessively drained. They formed in a mixture of volcanic ash and alluvium over glacial outwash and glacial till. They are on outwash terraces and moraines. Typically, the surface layer and subsoil are very gravelly sandy loam. The substratum is very

gravelly and extremely gravelly sand. In some areas dense glacial till is at a depth of 40 to 60 inches.

Of minor extent in this unit are the well drained Winston soils, mainly in the Columbia Valley; the somewhat poorly drained Clipper soils in depressions on outwash plains; and the well drained Barnhardt soils southwest of Everson.

This unit is used mainly as hayland and pasture, as woodland, or as cropland. It also is used as a site for homes and as a source of aggregate.

The main limitations in the areas used for hay and pasture or for crops are a low available water capacity and very gravelly surface layer in the Everett soils. The Kickerville soils are well suited to hay and pasture and

to cropland. All three soils are well suited to woodland. The main limitation affecting homesite development is the slope in some areas. Other limitations are the seasonal high water table and depth to the dense glacial till in some areas of the. Everett soils. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum of all the major soils.

## 5. Lynden-Hale-Tromp

*Very deep, well drained to somewhat poorly drained, level to gently sloping soils; on outwash terraces*

This map unit is in the western part of the survey area. Slope is 0 to 8 percent. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is 40 to 55 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 150 to 190 days.

This unit makes up about 10 percent of the survey area. It is about 23 percent Lynden soils, 21 percent Hale soils, 17 percent Tromp soils, and 39 percent soils of minor extent.

Lynden soils are well drained.<sup>1</sup> They formed in volcanic ash and loess over glacial outwash on outwash terraces. Typically, the surface layer and subsoil are sandy loam. The substratum is sand.

Hale soils are somewhat poorly drained but in most areas have been artificially drained. They formed in an admixture of loess and volcanic, ash over glacial outwash on outwash terraces. Typically, the surface layer is silt loam. The subsoil is mottled loam. The upper part of the substratum is mottled loamy fine sand. The lower part is sand.

Tromp soils are moderately well drained. They formed in a mixture of volcanic ash and loess over glacial outwash on outwash terraces. Typically, the surface layer is loam. The upper part of the subsoil also is loam. The lower part is weakly cemented, mottled sand. The substratum is mottled sand.

Of minor extent in this unit are the somewhat poorly drained Edmonds soils, the moderately well drained Laxton soils, the poorly drained Woodlyn soils, the somewhat excessively drained Lynnwood soils, the moderately well drained Yelm soils adjacent to soils that formed in glaciomarine drift, and the artificially drained Everson soils.

This unit is used mainly as hayland and pasture or as cropland (fig. 3). It also is used as woodland and as a site for homes.

The main limitations in the areas used for hay and pasture or for crops are the seasonal high water table in the Hale and Tromp soils and a moderate available water capacity in the Lynden and Hale soils. The main

limitation affecting timber harvesting is the muddiness caused by seasonal wetness in the Hale soils. The main limitation affecting homesite development and septic tank absorption fields are the seasonal high water table in the Hale and Tromp soils and a poor filtering capacity in the substratum of all the major soils. Lynden soils are well suited to homesite development.

## 6. Pangborn-Fishtrap-Shalcar

*Very deep, very poorly drained, nearly level soils that have been artificially drained; in depressions on outwash terraces, till. plains, and stream terraces*

This map unit is in depressions on outwash terraces. It is in the western part of the survey area. Slope is 0 to 2 percent. The native vegetation is mainly conifers and shrubs. Elevation is at or near sea level to 600 feet above sea level. The average annual precipitation is 35 to 55 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 150 to 190 days.

This unit makes up about 3 percent of the survey area. It is about 52 percent Pangborn soils, 16 percent Fishtrap soils, 16 percent Shalcar soils, and 16 percent soils of minor extent.

Pangborn soils formed in herbaceous and woody organic deposits in depressions on outwash terraces. Typically, the surface layer is muck. The underlying material also is muck.

Fishtrap soils formed in herbaceous and woody organic deposits over glaciofluvial deposits in depressions on outwash terraces. Typically, the surface layer is muck. The upper part of the underlying material also is muck. The lower part is mottled sand.

Shalcar soils formed in herbaceous and woody organic deposits over glaciofluvial deposits on outwash terraces, till plains, and stream terraces. Typically, the surface layer is muck. The upper part of the underlying material is loam. The lower part is gravelly sand.

Of minor extent in this unit are the poorly drained Bellingham, Snohomish, and Puget soils and the somewhat poorly drained Hale soils.

This unit is used mainly as hayland and pasture or as cropland. Undrained soils are used as woodland.

The main limitation in the areas used for hay and pasture or for crops is the seasonal high water table. The main limitations affecting homesite development are the seasonal high water table and low strength of the soils. The main limitation on sites for septic tank absorption fields is the seasonal high water table.

## Soils on Glaciomarine Drift Plains and Terraces

These soils make up about 17 percent of the survey area. They are level to very steep. The native



Figure 3.-An area of the Lynden-Hale-Tromp general soil map unit used as pasture.

vegetation is mainly trees and shrubs. Elevation is 20 to 600 feet. The average annual precipitation is 30 to 55 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 150 to 200 days.

These soils are very deep and are poorly drained to moderately well drained. Some areas have been artificially drained. The soils formed in alluvium, loess, volcanic ash, glaciomarine drift, glaciofluvial deposits, and glaciolacustrine sediments.

These soils are used mainly as hayland and pasture. They also are used as cropland and woodland.

## 7. Whatcom-Labounty

*Very deep, moderately well drained and poorly drained, level to very steep soils; dominantly on glaciomarine drift plains*

This map unit is in the western part of the survey area. Slope is 0 to 60 percent. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 600 feet.

The average annual precipitation is 35 to 55 inches, the average annual air temperature is 48 to 52. degrees F, and the average frost-free season is 150 to 190 days.

This unit makes up about 12 percent of the survey area. It is about 72 percent Whatcom soils, 24 percent Labounty soils, and 4 percent soils of minor extent.

Whatcom soils are moderately well drained. They formed in a mixture of loess and volcanic ash over glaciomarine drift. Typically, the surface layer is silt loam. The upper part of the subsoil also is silt loam. The lower part is mottled loam. The substratum also is mottled loam.

Labounty soils are poorly drained. In some areas they have been artificially drained. They formed in glaciomarine drift with an admixture of loess and volcanic ash. Typically, the surface layer is silt loam. The subsoil and substratum are mottled loam.

Of minor extent in this unit are the poorly drained Bellingham soils, the very poorly drained Histosols, and Urban land.

This unit is used mainly as hayland and pasture or as woodland. It also is used as cropland and as a site for homes.

The main limitations in the areas used for hay and pasture or for crops are the seasonal high water table and slow permeability in the substratum. The main limitation in the areas used as woodland is the muddiness caused by seasonal wetness. The main limitations affecting homesite development and septic tank absorption fields are the seasonal high water table in both soils, moderately slow permeability in the Labounty soils, and the slope of the Whatcom soils.

## **8. Birchbay-Whitehorn**

*Very deep, moderately well drained and poorly drained, level to gently sloping soils; on glaciomarine drift plains*

This map unit is near Lake Terrell on wave-reworked glaciomarine drift plains in the extreme western part of the survey area. Slope is 0 to 8 percent. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 350 feet. The average annual precipitation is 30 to 40 inches, the average annual air temperature is 48 to 52 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 48 percent Birchbay soils, 42 percent Whitehorn soils, and 10 percent soils of minor extent.

Birchbay soils are moderately well drained. They formed in an admixture of loess and volcanic ash over glaciofluvial deposits and glaciomarine drift. These soils are on the higher parts of the wave-reworked glaciomarine drift plains. Typically, the surface layer is silt loam. The upper part of the subsoil also is silt loam. The lower part is gravelly silt loam. The upper part of the substratum is very gravelly sand. The lower part is mottled loam.

Whitehorn soils are poorly drained. They formed in volcanic ash, loess, glaciofluvial deposits, and glaciomarine drift. These soils are in depressions on wave-reworked glaciomarine drift plains. Typically, the surface layer is silt loam. The upper part of the subsoil is loam and very fine sandy loam. The lower part is very gravelly sandy loam. The upper part of the substratum is mottled loam. The lower part is mottled silt loam.

Of minor extent in this unit are the moderately well drained Whatcom soils, the well drained Kickerville soils on terraces, and the poorly drained Labounty soils.

This unit is used mainly as hayland and pasture or as woodland. It also is used as cropland and as a site for homes.

The main limitations in the areas used for hay and pasture or for crops are the seasonal high water table and the ponding on the Whitehorn soils. The main

limitation affecting woodland is the muddiness caused by seasonal wetness. The main limitations affecting homesite development and septic tank absorption fields are the seasonal high water table and the slow permeability in the substratum.

## **9. Skipopa-Bellingham**

*Very deep, somewhat poorly drained and poorly drained, level to gently sloping soils; on terraces*

This map unit is in the western part of the survey area, mainly in an area north of Everson and in another area east of Birch Bay. Slope is 0 to 8 percent. The native vegetation is trees and shrubs. Elevation is 20 to 300 feet. The average annual precipitation is 30 to 50 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 160 to 200 days.

This unit makes up about 2 percent of the survey area. It is about 51 percent Skipopa soils, 41 percent Bellingham soils, and 8 percent soils of minor extent.

Skipopa soils are somewhat poorly drained. They formed in volcanic ash and loess over glaciolacustrine sediments on the higher parts of the undulating terraces. Typically, the surface layer is silt loam. The upper part of the subsoil also is silt loam. The lower part is mottled silty clay loam. The substratum also is mottled silty clay loam.

Bellingham soils are poorly drained. They formed in an admixture of loess, alluvium, and lacustrine deposits in depressions on undulating terraces. Typically, the surface layer is silty clay loam. The subsoil and substratum are mottled silty clay loam.

Of minor extent in this unit are Urban land and the poorly drained Blainegate soils near the town of Blaine.

This unit is used mainly as hayland and pasture. It also is used as woodland, as cropland, and as a site for homes.

The main limitations in the areas used for hay and pasture or for crops are the seasonal high water table and the very slow permeability in the substratum. The main limitation in the areas used as woodland is the muddiness caused by seasonal wetness. The main limitations affecting homesite development and septic tank absorption fields are the seasonal high water table and the very slow permeability in the substratum.

## **Soils on Foothills, Low Mountains, Plateaus, and Landslides**

These soils make up about 21 percent of the survey area. They are gently sloping to very steep. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 1,600 feet. The average annual precipitation is 35 to 70 inches, the average annual air temperature is

45 to 50 degrees F, and the average frost-free season is 140 to 200 days.

These soils are moderately deep to very deep and are moderately well drained and well drained. They formed dominantly in loess, volcanic ash, colluvium, and slope alluvium, in material weathered from phyllite, sandstone, and metasedimentary rocks, and in glacial drift.

These soils are used mainly as woodland.

## 10. Vanzandt-Squires

*Moderately deep, moderately well drained and well drained, gently sloping to very steep soils; dominantly on low mountains and foothills*

This map unit is in the south-central part of the survey area. Slope is 5 to 60 percent. The native vegetation is mainly conifers and shrubs. Elevation is 250 to 1,500 feet. The average annual precipitation is 45 to 70 inches, the average annual air temperature is 45 to 50 degrees F, and the average frost-free season is 140 to 180 days.

This unit makes up about 3 percent of the survey area. It is about 45 percent Vanzandt soils, 33 percent Squires soils, and 22 percent soils of minor extent.

Vanzandt soils are moderately well drained. They formed in volcanic ash, loess, and slope alluvium over glacial till derived dominantly from phyllite. They are on low mountains. Typically, the surface is covered with a mat of organic material. The surface layer is very gravelly loam. The subsoil also is very gravelly loam. The substratum is mottled very gravelly loam. Dense glacial till is at a depth of 31 inches. Depth to the dense glacial till ranges from 20 to 40 inches.

Squires soils are well drained. They formed in a mixture of volcanic ash, loess, glacial till, and colluvium derived dominantly from phyllite. They are on foothills and low mountain back slopes and toe slopes. Typically, the surface is covered with a mat of organic material. The surface layer is very channery silt loam. The subsoil is very channery loam. The substratum is very channery sandy loam. Phyllite is at a depth of 30 inches. Depth to the phyllite ranges from 20 to 40 inches.

Of minor extent in this unit are the well drained Heisler soils east and south of Vanzandt Dike and Wickersham and Wiseman soils on alluvial fans and terraces in the valley of the South Fork of the Nooksack River.

This unit is used as woodland. The main limitations affecting timber harvesting are the slope and the muddiness caused by seasonal wetness.

## 11. Squalicum-Chuckanut-Nati

*Moderately deep to very deep, moderately well drained and well drained, gently sloping to very steep soils; on foothills, plateaus, and landslides*

This map unit is on foothills in the eastern and southern parts of the survey area. Slope is 3 to 60 percent. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 1,600 feet. The average annual precipitation is 35 to 60 inches, the average annual air temperature is 45 to 50 degrees F, and the average frost-free season is 140 to 200 days.

This unit makes up about 18 percent of the survey area. It is about 24 percent Squalicum soils, 16 percent Chuckanut soils, 15 percent Nati soils, and 45 percent soils of minor extent.

Squalicum soils are deep and moderately well drained. They formed in a mixture of volcanic ash, loess, and slope alluvium over glacial till. They are on foothills. Typically, the surface is covered with a mat of organic material. The surface layer is loam. The upper part of the subsoil also is loam. The lower part is gravelly loam. The substratum also is gravelly loam. Dense glacial till is at a depth of 44 inches. Depth to the dense glacial till ranges from 40 to 60 inches.

Chuckanut soils are very deep and deep and are well drained. They formed in a mixture of volcanic ash and colluvium derived from glacial drift and sandstone. They are on foothills and landslides. Typically, the surface layer is loam. The subsoil is sandy loam and gravelly loam. The substratum is gravelly sandy loam. Some Chuckanut soils have sandstone at a depth of 40 to 60 inches.

Nati soils are moderately deep and well drained. They formed in colluvium and slope alluvium derived from sandstone and siltstone with an admixture of volcanic ash and glacial till. They are on foothills and plateaus. Typically, the surface is covered with a mat of organic material. The surface layer and the subsoil are loam. The substratum is fine sandy loam. Sandstone is at a depth of 31 inches. Depth to the sandstone ranges from 20 to 40 inches.

Of minor extent in this unit are the well drained Andic Xerochrepts on extremely steep slopes, the well drained Blethen soils, and the moderately well drained Sehome soils. Also of minor extent are the moderately well drained Comar soils north of Deming, the well drained Pickett soils on Lummi Island, the very poorly drained Shalcar soils, and Rock outcrop.

This unit is used mainly as woodland. It also is used as hayland and pasture and as a site for homes.

Erosion is a hazard in the areas used for hay and

pasture. The main limitations affecting timber harvesting are the slope on part of the unit and the muddiness caused by seasonal wetness. The main limitations affecting homesite development and septic tank absorption fields are the slope, the moderate depth to bedrock or dense glacial till, and the seasonal high water table in the Squalicum soils.

### **Soils on Mountains, Plateaus, and Ridges**

These soils make up about 12 percent of the survey area. They are gently sloping to very steep. The native vegetation is conifers and shrubs. Elevation is 1,000 to 2,500 feet. The average annual precipitation is 45 to 85 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free season is 100 to 150 days.

These soils are moderately deep and very deep and are moderately well drained and well drained. They formed in volcanic ash, colluvium, and slope alluvium, in material weathered from phyllite, sandstone, and metasedimentary rocks, and in glacial drift.

These soils are used mainly as woodland.

### **12. Montborne-Rinker**

*Moderately deep, moderately well drained and well drained, gently sloping to very steep soils; on mountain back slopes, shoulder slopes, and plateaus*

This map unit is in the south-central part of the survey area. Slope is 5 to 60 percent. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 2,000 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free season is 100 to 150 days.

This unit makes up about 3 percent of the survey area. It is about 48 percent Montborne soils, 25 percent Rinker soils, and 27 percent soils of minor extent.

Montborne soils are moderately well drained. They formed in an admixture of volcanic ash, loess, colluvium, and slope alluvium over glacial till derived dominantly from phyllite. They are on mountain back slopes and plateaus. Typically, the surface is covered with a mat of organic material. The surface layer is gravelly loam. The subsoil is very gravelly loam. The substratum is extremely gravelly sandy loam. Dense glacial till is at a depth of 33 inches. Depth to the dense glacial till ranges from 20 to 40 inches.

Rinker soils are well drained. They formed in a mixture of volcanic ash, colluvium, and slope alluvium derived dominantly from phyllite. They are on mountain back slopes and shoulder slopes. Typically, the surface

is covered with a mat of organic material. The surface layer is very channery silt loam. The subsoil is very channery silt loam and extremely channery silt loam. The substratum is extremely channery loam. Phyllite is at a depth of 30 inches. Depth to the phyllite ranges from 20 to 40 inches.

Of minor extent in this unit are the well drained Sandun and Sorensen soils. Sandun soils formed in dunite-influenced material along the Middle Fork of the Nooksack River.

This unit is used as woodland. The main limitations affecting timber harvesting are the slope and the muddiness caused by seasonal wetness.

### **13. Oakes-Revel**

*Very deep and moderately deep, well drained, gently sloping to very steep soils; on mountain back slopes, ridges, and plateaus*

This map unit is in the eastern and southern parts of the survey area. Slope is 5 to 80 percent. The native vegetation is conifers and shrubs. Elevation is 1,000 to 2,500 feet. The average annual precipitation is 45 to 85 inches, the average annual air temperature is 41 to 45 degrees F, and the average frost-free season is 100 to 150 days.

This unit makes up about 9 percent of the survey area. It is about 40 percent Oakes soils, 13 percent Revel soils, and 47 percent soils of minor extent.

Oakes soils are very deep. They formed in volcanic ash, colluvium, and slope alluvium derived from glacial drift. They are on mountain back slopes. Typically, the surface is covered with a mat of organic material. The surface layer and the upper part of the subsoil are very gravelly loam. The lower part is extremely gravelly sandy loam. The substratum is extremely cobbly fine sandy loam.

Revel soils are moderately deep. They formed in a mixture of volcanic ash, colluvium, and slope alluvium derived dominantly from sandstone, siltstone, and glacial till. They are on mountain back slopes, ridges, and plateaus. Typically, the surface is covered with a mat of organic material. The surface layer and subsoil are loam. The substratum is sandy loam. Sandstone is at a depth of 35 inches. Depth to the sandstone ranges from 20 to 40 inches.

Of minor extent in this unit are the well drained Andic Xerochrepts on extremely steep slopes, the moderately well drained Cupples soils, the somewhat excessively drained Skykomish soils, the well drained Welcome soils, and Rock outcrop.

This unit is used as woodland. The main limitations

affecting timber harvesting are the slope and occasional snowpack.

#### **Soils on High Mountains, Plateaus, and Ridges**

These soils make up about 18 percent of the survey area. They are gently sloping to extremely steep. The native vegetation is conifers and shrubs. Elevation is 1,800 to 5,500 feet. The average annual precipitation is 70 to 105 inches, the average annual air temperature is 40 to 43 degrees F, and the average frost-free season is 80 to 110 days.

These soils are shallow to very deep and are moderately well drained and well drained. They formed dominantly in volcanic ash, loess, slope alluvium, and colluvium over glacial till derived from sandstone, phyllite, dunite, and serpentine.

These soils are used mainly as woodland.

#### **14. Getchell-Kindy-Potchub**

*Moderately deep, moderately well drained, gently sloping to very steep soils; on high mountains, plateaus, and ridges*

This map unit is in the northeastern part of the survey area. Slope is 3 to 60 percent. The native vegetation is conifers and shrubs. Elevation is 1,800 to 4,500 feet. The average annual precipitation is 70 to 105 inches, the average annual air temperature is 40 to 43 degrees F, and the average frost-free season is 80 to 110 days.

This unit makes up about 5 percent of the survey area. It is about 30 percent Getchell soils, 30 percent Kindy soils, 20 percent Potchub soils, and 20 percent soils of minor extent.

Getchell soils formed in an admixture of volcanic ash and colluvium over glacial till. They are on high mountains and plateaus. Typically, the surface is covered with a mat of organic material. The surface layer is loam. The subsoil is sandy loam. Dense glacial till is at a depth of 36 inches. Depth to the dense glacial till ranges from 20 to 40 inches.

Kindy soils formed in a mixture of volcanic ash, loess, and colluvium over glacial till. They are on high mountains and plateaus. Typically, the surface is covered with a mat of organic material. The surface layer is gravelly silt loam. The upper part of the subsoil is very gravelly silt loam. The lower part is very gravelly loam. Dense glacial till is at a depth of 25 inches. Depth to the dense glacial till ranges from 20 to 40 inches.

Potchub soils formed in an admixture of volcanic ash, loess, and colluvium over glacial till. They are on high mountains and ridges. Typically, the surface is covered with a mat of organic material. The surface layer is loam. The subsoil is gravelly loam and gravelly sandy

loam. Dense glacial till is at a depth of 39 inches. Depth to the dense glacial till ranges from 20 to 40 inches.

Of minor extent in this unit are the Hartnit, Saar, Oso, Gallup, and Shuksan soils. Also of minor extent are Clendenen, Deming, Kulshan, and Hozomeen soils and Rock outcrop.

This unit is used as woodland. The main limitations affecting timber harvesting are the slope and snowpack.

#### **15. Hinker-Crinker-Springsteen**

*Moderately deep, well drained, moderately steep to very steep soils; on high mountains*

This map unit is in the southeastern part of the survey area. Slope is 15 to 60 percent. The native vegetation is conifers and shrubs. Elevation is 1,800 to 4,200 feet. The average annual precipitation is 70 to 105 inches, the average annual air temperature is 40 to 43 degrees F, and the average frost-free season is 80 to 110 days.

This unit makes up about 3 percent of the survey area. It is about 34 percent Hinker soils, 25 percent Crinker soils, 20 percent Springsteen soils, and 21 percent soils of minor extent.

Hinker soils formed in a mixture of volcanic ash, loess, and colluvium derived dominantly from phyllite. Typically, the surface is covered with a mat of organic material. The surface layer is very channery silt loam. The upper part of the subsoil is very cobbly silt loam. The lower part is very channery silt loam. Phyllite is at a depth of 21 inches. Depth to the phyllite ranges from 20 to 40 inches.

Crinker soils formed in an admixture of volcanic ash, slope alluvium, colluvium, and glacial till derived dominantly from phyllite. Typically, the surface is covered with a mat of organic material. The surface layer is very channery silt loam. The subsoil is also very channery silt loam. Phyllite is at a depth of 24 inches. Depth to the phyllite ranges from 20 to 40 inches.

Springsteen soils formed in a mixture of volcanic ash, colluvium, and glacial till derived from phyllite. Typically, the surface is covered with a mat of organic material. The surface layer is very gravelly loam. The subsoil also is very gravelly loam. Phyllite is at a depth of 24 inches. Depth to the phyllite ranges from 20 to 40 inches.

Of minor extent in this unit are the moderately well drained Wollard and Diobsud soils that formed in glacial till and the shallow Hannegan soils. Also of minor extent are some small areas of Typic Cryorthods and Kindy, Saar, Hozomeen, and Klawatti soils. Soils of minor extent make up about 25 percent of the unit.

This unit is used as woodland. The main limitations affecting timber harvesting are the slope and snowpack.

## 16. Edfro-Klawatti-Twinsi

*Shallow and moderately deep, moderately well drained and well drained, moderately steep to very steep soils; on high mountains*

This map unit is dominantly in the southeastern part of the survey area, adjacent to Twin Sisters Mountain with a small serpentine area on Sumas Mountain. Slope is 15 to 60 percent. The native vegetation is conifers and shrubs. Elevation is 2,000 to 4,300 feet. The average annual precipitation is 90 to 100 inches, the average annual air temperature is 41 to 43 degrees F, and the average frost-free season is 90 to 105 days.

This unit makes up about 2 percent of the survey area. It is about 26 percent Edfro soils, 25 percent Klawatti soils, 20 percent Twinsi soils, and 29 percent soils of minor extent.

Edfro soils are shallow and moderately well drained. They formed in a mixture of volcanic ash, loess, and colluvium over glacial till derived dominantly from dunite. Typically, the surface is covered with a mat of organic material. The surface layer is very gravelly silt loam. The upper part of the subsoil is extremely gravelly silt loam. The lower part is extremely gravelly loam. Dense glacial till is at a depth of 19 inches. Depth to the dense glacial till ranges from 14 to 20 inches.

Klawatti soils are moderately deep and well drained. They formed in volcanic ash, slope alluvium, and colluvium derived dominantly from dunite and serpentine. Typically, the surface is covered with a mat of organic material. The surface layer is very gravelly silt loam. The subsoil is extremely gravelly silt loam. Dunite is at a depth of 25 inches. Depth to the dunite ranges from 20 to 40 inches.

Twinsi soils are moderately deep and moderately well drained. They formed in colluvium and glacial till with an admixture of volcanic ash and loess. The colluvium and glacial till are dominantly derived from dunite. Typically, the surface is covered with a mat of organic material. The surface layer is very gravelly loam. The subsoil also is very gravelly loam. The substratum is very gravelly sandy loam. Dense glacial till is at a depth of 27 inches. Depth to the dense glacial till ranges from 20 to 40 inches.

Of minor extent are the very deep, well drained Jackman soils and the very deep, somewhat excessively drained Jorgenson soils. These soils make up about 25 percent of the unit. Also included are the Kindy, Hozomeen, and Saar soils, Rock outcrop, and Rubble land.

This unit is used as woodland. The main limitations affecting the timber harvesting are the slope and snowpack.

## 17. Rock Outcrop-Typic Cryorthods-Andic Cryochrepts

*Moderately deep to very deep, well drained, very steep soils; on high mountains and ridges*

This map unit is in the northeastern part of the survey area. Slope is 60 to 100 percent. The native vegetation is conifers and shrubs. Elevation is 1,800 to 5,500 feet. The average annual precipitation is 70 to 105 inches, the average annual air temperature is 40 to 43 degrees F, and the average frost-free season is 80 to 110 days.

This unit makes up about 8 percent of the survey area. It is about 29 percent Rock outcrop, 24 percent Typic Cryorthods, 13 percent Andic Cryochrepts, and 34 percent soils of minor extent.

Rock outcrop is dominantly sandstone. It is hard and mostly unweathered. It occurs as steep cliffs and irregular formations.

Typic Cryorthods formed in volcanic ash, colluvium and residuum from sandstone, and glacial till derived from phyllite. Commonly, the surface layer, subsoil, and substratum are loam. The texture, content of rock fragments, and depth to glacial till or bedrock vary widely within short distances.

Andic Cryochrepts formed in a mixture of volcanic ash, glacial till, and colluvium derived dominantly from sandstone. Commonly, the surface is covered with a mat of organic material. The surface layer, subsoil, and substratum are very gravelly loam. The texture, content of rock fragments, and depth to dense glacial till or bedrock vary widely within short distances.

Of minor extent in this unit are the Kulshan, Shuksan, Gallup, and Hartnit soils. Also of minor extent are Kindy, Oso, Getchell, Saar, and Potchub soils.

This unit is used as woodland. The main limitations affecting timber harvesting are the slope and snowpack.

## Broad Land Use Considerations

The soils in the survey area vary widely in their potential for major land uses. Approximately 15 percent of the survey area is used for cultivated crops, mainly berries, potatoes, and truck crops. This cropland is in the western part of the survey area and is concentrated in general soil map units 1 through 6. The soils in these map units have high potential for crops. The soils in units 1, 2, and 3, however, are occasionally flooded, generally in winter and spring. The flooding causes slight or moderate crop damage. Wetness is the main limitation. The main soils used for cultivated crops in units 1, 2, and 3 are Mt. Vernon, Briscot, Puyallup, Oridia, and Eliza soils. The soils in units 4 and 5 are on outwash terraces. A low or moderate available water

capacity and the seasonal high water table are the main limitations. The main soils used for cultivated crops in units 4 and 5 are Kickerville, Lynden, Hale, and Tromp soils. The Pangborn, Fishtrap, and Shalcar soils in unit 6 are in depressions on outwash terraces. The high water table is the main limitation.

Approximately 20 percent of the survey area is used for pasture. Units 1 through 9 have high potential for grasses and legumes. Examples of soils used for pasture are Mt. Vernon, Briscot, Puyallup, and Oridia soils on flood plains; Kickerville, Hale, Tromp, and Pangborn soils on outwash terraces; and Whatcom, Labounty, Birchbay, Whitehorn, Skipopa, and Bellingham soils on glaciomarine drift plains and lacustrine terraces. The main limitations in units 7, 8, and 9 are the seasonal high water table and slow permeability in the substratum. The main limitation in units 4 and 5 and in the Puyallup soils in unit 1 is a low or moderate available water capacity. Grazing should be restricted in winter and spring, when the soils are saturated.

About 62 percent of the survey area is used as woodland. The productivity for conifers ranges from low to high. The soils in units 10 through 13 can produce the largest amount of wood, especially Squalicum, Oakes, Chuckanut, and Nati soils. Units 4, 5, 7, 8, 14, 15, 16, and 17 also can produce large amounts of wood. The main soils used for woodland are Barneston, Shuksan, Kindy, Getchell, Everett, Whatcom, and Birchbay soils. The use of equipment is restricted on most soils during wet periods. The main limitation affecting timber harvesting is snowpack in units 12, 13, 14, 15, 16, and 17. The slope and the muddiness caused by seasonal wetness are limitations in all of the units. Plant competition is generally the most serious hazard, although seedling mortality is the main hazard in unit 14. The hazard of windthrow on most soils and the hazard of erosion on the steeper slopes also are important management concerns.

About 15,000 acres, or 3 percent of the county, is used as urban or built-up land. The main built-up areas are in units 4, 5, 7, 8, and 11. In more than 70 percent of the survey area, the soils have severe limitations as sites for septic tank absorption fields. The Whatcom, Labounty, Birchbay, and Whitehorn soils in units 7 and 8 are used as sites for homes. The main limitations in these units are the seasonal high water table and the slow permeability in the substratum. The Squalicum, Chuckanut, Lynden, Everett, and Kickerville soils in units 4, 5, and 11 are used as sites for homes. The main limitations in these units are the seasonal high water table and the depth to dense glacial till in the

Squalicum and Everett soils, the depth to bedrock in the Chuckanut soils, and the slope of the Chuckanut, Everett, and Squalicum soils. In the other units in the survey area, wetness, the slope, the hazard of flooding, a poor filtering capacity in the substratum, the depth to bedrock, and low strength are the principal limitations.

The potential for recreational uses is low to high, depending on the intensity of the expected use and the properties of the soil. Most of the soils in units 4, 5, and 6 have high potential for intensive recreational uses. Most of the lakes in Whatcom County are located in these map units. Units 1, 2, and 3 usually have low potential for recreational uses because the soils are subject to flooding. The potential is high, however, in the summer. The slope in units 7 through 14 is a limitation in intensively used recreational areas, such as playgrounds and camp areas. All of these units, however, are suitable for extensive recreational areas, such as those used for hiking, horseback riding, hunting, fishing, and motorbiking. Small areas that are suited to intensive development are available in most of the map units.

In all of the units, except for unit 14, the potential for openland wildlife habitat is moderate or high and the potential for woodland wildlife habitat is high. Unit 14 has low potential for openland wildlife habitat and moderate potential for woodland wildlife habitat. The well-being of wildlife is largely determined by the quantity and quality of the habitat elements produced on the soils managed for woodland, pasture, or cultivated crops. The soils on the flood plains in units 1, 2, and 3, the organic soils in unit 6, and the soils in level areas of units 4, 5, 7, 8, and 9 have high potential for wetland wildlife habitat.

Timber management practices that improve woodland wildlife habitat include establishing scattered, small, irregularly shaped open areas among the trees; maintaining snags; maintaining uneven-aged stands of mixed species; and protecting riparian vegetation and the water quality in streams.

Conservation practices that improve openland wildlife habitat include growing cover crops, maintaining abundant crop residue during winter, leaving uncultivated strips of vegetation along shorelines and streambanks, ensuring proper grazing of pasture, closely regulating livestock use in streams and on wetlands, and controlling runoff of animal waste.

Wetland habitat can be maintained or improved by protecting riparian vegetation from cultivation, fire, herbicides, and excessive grazing; by protecting wetlands from excessive sedimentation; and by ensuring that the wetlands are not drained.

# Detailed Soil Map Units

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

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

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

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

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, depth to bedrock, wetness, temperature, degree of drainage, 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, Chuckanut loam, bedrock substratum, 5 to 15 percent slopes, is a phase of the Chuckanut series.

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

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Edmonds-Woodlyn loams, drained, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Shalcar and Fishtrap soils, 0 to 2 percent slopes, is an undifferentiated group in this survey area.

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

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

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

## Soil Descriptions

### **1-Andic Cryochrepts, 60 to 90 percent slopes.**

These moderately deep to very deep, well drained soils are on high mountains and ridges. They formed in a mixture of volcanic ash, glacial till, and colluvium derived from sandstone and metasedimentary rocks. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 105 days.

No single profile is representative of these soils. In

one of the more commonly observed ones, however, the surface is covered with a mat of leaves and twigs about 7 inches thick. Typically, the surface layer is grayish brown very gravelly loam 7 inches thick. The subsoil is olive brown very gravelly loam 23 inches thick. The substratum to a depth of 60 inches is light olive brown very gravelly loam. The texture, the content of rock fragments, and the depth to dense glacial till or bedrock vary widely within short distances. In many areas dense glacial till is at a depth of more than 30 inches. The depth to bedrock is more than 40 inches. The content of hard rock fragments in the control section ranges from 15 to 60 percent by weighted average. The content of weathered rock fragments ranges from 10 to 60 percent by weighted average. The part of the profile having properties associated with weathered volcanic ash is 10 to more than 60 inches thick.

Included in this unit are small areas of Getchell, Kindy, Oakes, and Springsteen soils, soils that are less than 40 inches deep over bedrock, Rock outcrop, slumps, and stony areas. Included areas make up about 15 percent of the total acreage.

Permeability is moderate or moderately rapid in the Andic Cryochrepts. Available water capacity is moderate or high. The effective rooting depth is more than 30 inches. Runoff is medium, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir and western redcedar. The common understory plants are tall blue huckleberry, bunchberry dogwood, salal, red huckleberry, Oregongrape, and longtube twinflower.

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, it is 89. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 190 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, the hazard of erosion, and snowpack. Cable yarding systems generally are used on this unit. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. During an average year, the snowpack limits the use of equipment and restricts access from December through April. Unsurfaced roads are slippery and soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is generally not readily available. Cut and fill slopes tend

to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. The areas underlain by dense glacial till are most prone to landslides. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. Because the rooting depth is restricted by the dense glacial till and bedrock within a depth of 40 inches in some areas, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

This map unit is in capability subclass VIIe.

**2-Andic Cryochrepts-Rock outcrop complex, 60 to 90 percent slopes.** This map unit is on high mountains and ridges. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 105 days.

This unit is 70 percent Andic Cryochrepts and 20 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Getchell, Kindy, Oakes, and Springsteen soils and soils that are less than 40 inches deep over bedrock. Also included are small areas of slumps, stony areas, and areas where slopes are 40 to 60 percent. Included areas make up about 10 percent of the total acreage.

The Andic Cryochrepts are moderately deep to very

deep and are well drained. They formed in a mixture of volcanic ash, glacial till, and colluvium derived from sandstone and metasedimentary rocks. No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface is covered with a mat of leaves and twigs about 7 inches thick. Typically, the surface layer is grayish brown very gravelly loam 7 inches thick. The subsoil is olive brown very gravelly loam 23 inches thick. The substratum to a depth of 60 inches is light olive brown very gravelly loam. The texture, the content of rock fragments, and the depth to dense glacial till or bedrock vary widely within short distances. In many areas dense glacial till is at a depth of more than 30 inches. The depth to bedrock is more than 40 inches. The content of hard rock fragments in the particle-size control section ranges from 15 to 60 percent by weighted average. The content of weathered rock fragments ranges from 10 to 60 percent by weighted average. The part of the profile having properties associated with weathered volcanic ash is 10 to more than 60 inches thick.

Permeability is moderate or moderately rapid in the Andic Cryochrepts. Available water capacity is moderate or high. The effective rooting depth is more than 30 inches. Runoff is medium, and the hazard of water erosion is severe.

Typically, the Rock outcrop is sandstone or metasedimentary rock. It is hard and generally unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir and western redcedar. The common understory plants are tall blue huckleberry, bunchberry dogwood, salal, red huckleberry, Oregongrape, and longtube twinflower.

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, it is 89. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 190 cubic feet per acre per year, occurring at age 50. Yields are reduced by the extent of the Rock outcrop. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, the hazard of erosion, snowpack, and the Rock outcrop. The trees can break if they are felled on the Rock outcrop. The pattern of the Rock outcrop on the landscape results in a discontinuous slope, which hinders the use of cable yarding systems. These systems generally are used on this unit. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems

generally are safer and disturb the surface less extensively. During an average year, the snowpack limits the use of equipment and restricts access from December through April. Unsurfaced roads are slippery and soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is generally not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. The areas underlain by dense glacial till are most prone to landslides. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production.

Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the underlying soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gully erosion unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. The Rock outcrop prevents the even distribution of reforestation. Because the rooting depth is restricted by the dense glacial till and bedrock in some areas, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

The Andic Cryochrepts are in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

**3-Andic Xerochrepts, 60 to 90 percent slopes.** These moderately deep to very deep, well drained soils are on mountainsides, canyonsides, and ridges. They formed in volcanic ash, colluvium derived from glacial till, sandstone, and metasedimentary rocks. The native vegetation is mainly conifers and shrubs. Elevation is 20 to 1,500 feet. The average annual precipitation is about 50 inches, the average annual air temperature is

about 46 degrees F, and the average frost-free period is about 130 days.

No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface is covered with a mat of leaves and twigs about 3 inches thick. Typically, the surface layer is very dark grayish brown loam 3 inches thick. The subsoil is dark yellowish brown loam 19 inches thick. The substratum is dark yellowish brown loam 5 inches thick. Sandstone is at a depth of about 27 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. The texture, the content of rock fragments, and the depth to sandstone, metasedimentary rock, or dense glacial till vary widely within short distances. If present, dense glacial till is at a depth of more than 40 inches and bedrock is at a depth of 20 to 60 inches. The content of hard rock fragments in the particle-size control section ranges from 15 to 60 percent by weighted average. The content of weathered rock fragments ranges from 10 to 60 percent by weighted average. The part of the profile having properties associated with weathered volcanic ash is 10 to more than 60 inches thick.

Included in this unit are small areas of Pickett, Nati, Revel, Chuckanut, Blethen, Montborne, Vanzandt, and Oakes soils, soils that are less than 20 inches deep over bedrock, Rock outcrop, slumps, stony areas, and areas of Andic Xerochrepts that have slopes of 40 to 60 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate or moderately rapid in the Andic Xerochrepts. Available water capacity is moderate or high. The effective rooting depth is more than 20 inches. Runoff is medium, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are salal, red huckleberry, Oregongrape, western swordfern, and vine maple.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 140. On the basis of a 50-year site curve, it is 107. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 145 cubic feet per acre per year, occurring at age 65. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, the hazard of erosion, and occasional snowpack. Cable yarding systems generally are used on this unit. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. During an

average year, the snowpack limits the use of equipment and restricts access in January and February. Unsurfaced roads are slippery and soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is generally not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. The areas underlain by dense glacial till are most prone to landslides. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir, red alder, or western hemlock seedlings. Because of the slope, planting seedlings by hand is difficult. If seed trees are available, natural reforestation of cutover areas by red alder and western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Because the rooting depth is restricted by the dense glacial till and bedrock in some areas, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

This map unit is in capability subclass VIIe.

#### **4-Andic Xerochrepts-Rock outcrop complex, 60 to 90 percent slopes.**

This map unit is on mountainsides, canyonsides, and ridges. The native vegetation is mainly conifers and shrubs. Elevation is 20 to 1,200 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 140 days.

This unit is 75 percent Andic Xerochrepts and 15 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Pickett, Nati, Chuckanut, Blethen, and Vanzandt soils. Also included are small areas of slumps, soils that have serpentinitic mineralogy, stony areas, soils that are less than 20 inches deep over bedrock or dense glacial till, and areas of Andic Xerochrepts that have slopes of 40 to 60

percent. Included areas make up about 10 percent of the total acreage.

The Andic Xerochrepts are moderately deep to very deep and are well drained. They formed in volcanic ash, colluvium derived from glacial till, sandstone, and metasedimentary rocks. No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface is covered with a mat of leaves and twigs about 2 inches thick. Typically, the surface layer is dark brown loam 6 inches thick. The subsoil is dark brown loam 11 inches thick. The substratum is dark yellowish brown sandy loam 12 inches thick. Sandstone is at a depth of about 29 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. The texture, the content of rock fragments, and the depth to bedrock or dense glacial till vary widely within short distances. If present, the dense glacial till is at a depth of more than 40 inches. The content of hard rock fragments in the particle-size control section ranges from 15 to 60 percent by weighted average. The content of weathered rock fragments ranges from 10 to 60 percent by weighted average. The part of the profile having properties associated with weathered volcanic ash is 10 to more than 60 inches thick.

Permeability is moderate or moderately rapid in the Andic Xerochrepts. Available water capacity is moderate or high. The effective rooting depth is more than 20 inches. Runoff is medium, and the hazard of water erosion is severe.

Typically, the Rock outcrop is sandstone or metasedimentary rock. It is hard and generally unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are salal, red huckleberry, Oregon grape, western swordfern, and vine maple.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 140. On basis of a 50-year site curve, it is 107. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 145 cubic feet per acre per year, occurring at age 65. Yields are reduced by the extent of the Rock outcrop. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, the hazard of erosion, and the Rock outcrop. The trees can break if they are felled on the Rock outcrop. The pattern of the Rock outcrop on the landscape results in a discontinuous slope, which hinders the use of cable yarding systems. These systems generally are used on this unit. When timber is

harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. During an average year, snowpack limits the use of equipment and restricts access in January and February. Unsurfaced roads are slippery and soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is generally not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production.

Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the underlying soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir, red alder, or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and red alder occurs readily. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Because the rooting depth is restricted by the bedrock and dense glacial till in some places, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

The Andic Xerochrepts are in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

**5-Andic Xerochrepts, cool-Rock outcrop complex, 60 to 90 percent slopes.** This map unit is on mountainsides, canyonsides, and ridges. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 2,300 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 44 degrees F, and the average frost-free period is about 120 days.

This unit is 75 percent Andic Xerochrepts and 15 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Revel, Montborne, Oakes, Sorensen, and Rinker soils, soils that are less than 20 inches deep over bedrock or dense glacial till, soils that have serpentinitic mineralogy, slumps, stony areas, and areas of Andic Xerochrepts that have slopes of 40 to 60 percent. Included areas make up about 10 percent of the total acreage.

The Andic Xerochrepts are moderately deep to very deep and are well drained. They formed in volcanic ash, colluvium derived from glacial till, sandstone, and metasedimentary rocks. No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface is covered with a mat of leaves and twigs about 3 inches thick. Typically, the surface layer is dark brown loam 7 inches thick. The subsoil is yellowish brown loam 24 inches thick. The substratum to a depth of 60 inches is yellowish brown loam. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile, and the depth to bedrock or dense glacial till varies widely within short distances. In many areas dense glacial till is at a depth of more than 40 inches. If present, bedrock is at a depth of more than 20 inches. The content of hard rock fragments in the particle-size control section ranges from 15 to 60 percent by weighted average. The content of weathered rock fragments ranges from 10 to 60 percent by weighted average. The part of the profile having properties associated with volcanic ash is 10 to more than 60 inches thick.

Permeability is moderate or moderately rapid in the Andic Xerochrepts. Available water capacity is moderate or high. The effective rooting depth is more than 20 inches. Runoff is medium, and the hazard of water erosion is severe.

Typically, the Rock outcrop is sandstone or metasedimentary rock. It is hard and generally unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Western hemlock and Douglas fir are the main woodland species. Among the trees of limited extent is western redcedar. The common understory plants are salal, red huckleberry, Oregongrape, western swordfern, and vine maple.

On the basis of a 100-year site curve, the mean site index is 134 for western hemlock and 117 for Douglas fir. On the basis of a 50-year site curve, it is 96 for western hemlock and 85 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 207 cubic feet per acre per year, occurring at age 50. For Douglas fir, it is 110 cubic feet per acre per year, occurring at age 60. Yields are reduced by the extent of the Rock outcrop. Areas on

ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, the hazard of erosion, occasional snowpack, and the Rock outcrop. The trees can break if they are felled on the Rock outcrop. The pattern of the Rock outcrop on the landscape results in a discontinuous slope, which hinders the use of cable yarding systems. These systems generally are used on this unit. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. During an average year, the snowpack limits the use of equipment and restricts access from December through March. Unsurfaced roads are slippery and soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is generally not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. The areas underlain by dense glacial till are most prone to landslides. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production.

Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the underlying soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Because the rooting depth is restricted by the bedrock and dense glacial till in some areas, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

The Andic Xerochrepts are in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

#### **6-Barneston gravelly loam, 0 to 8 percent slopes.**

This very deep, somewhat excessively drained soil is on outwash terraces. It formed in an admixture of loess

and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 1,000 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2.5 inches thick. When mixed to a depth of 8 inches, the surface layer is dark brown gravelly loam. The subsoil is dark brown very gravelly loam 6 inches thick. The upper 26 inches of the substratum is dark yellowish brown and olive brown extremely gravelly sand. The lower part to a depth of 60 inches is dark grayish brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 13 to 24 inches. In some areas the surface layer is very gravelly loam, very gravelly sandy loam, or cobbly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, has a substratum of extremely gravelly sand at a depth of 24 to 36 inches, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Sehome and Blethen soils, poorly drained soils in depressions, and Barneston soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Barneston soil and very rapid in the substratum. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture, as a source of aggregate, and as a site for homes.

The main limitation in the areas used for hay and pasture is the low available water capacity. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition, minimize compaction, and reduce the runoff rate. In summer, irrigation is required for maximum production. Erosion is a hazard during periods of reestablishment.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, red alder, and bigleaf maple. The common understory plants are Oregongrape, salal, western swordfern, western brackenfern, red huckleberry, and vine maple.

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, it is 118. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 158 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the

muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. A high soil temperature and a low content of moisture in the soil during the growing season cause a high rate of seedling mortality. If seed trees are available, natural reforestation of cutover areas by Douglas fir, red alder, and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is well suited to homesite development. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum.

This map unit is in capability subclass IIIe.

**7-Barneston very gravelly loam, 8 to 15 percent slopes.** This very deep, somewhat excessively drained soil is on outwash terraces and on slopes between the terraces. It formed in an admixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 400 to 1,000 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 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 4 inches thick. The upper 7 inches of the subsoil is dark brown very gravelly loam. The lower 8 inches is strong brown very gravelly loam. The substratum to a depth of 60 inches is dark grayish brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 13 to 24 inches. In some areas the surface layer is gravelly loam, very gravelly sandy loam, or cobbly loam. In other areas the soil has less than 35 percent rock fragments

in the subsoil, has a substratum of extremely gravelly sand at a depth of 24 to 36 inches, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Sehome and Blethen soils and small areas of Barneston soils that have slopes of more than 15 percent or less than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Barneston soil and very rapid in the substratum. Available water capacity is low.; The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used as a source of aggregate and as a site for homes.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, red alder, and bigleaf maple. The common understory plants are Oregongrape, western swordfern, western brackenfern, red huckleberry, and vine maple.

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, it is 118. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 158 cubic feet per acre per year, occurring at age 60.

The kind of equipment that can be used and the time of the year when it can be used. normally are not restricted on this unit. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. A high soil temperature and a low content of moisture in the soil during the growing season cause a high rate of seedling mortality. If seed trees are available, natural reforestation of cutover areas by Douglas fir, red alder, and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

If this unit is used for homesite development, the main limitation is the slope. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope. The slope affects the installation of septic tank absorption fields. The absorption lines should be installed on the contour.

This map unit is in capability subclass IVe.

#### **8-Barneston very gravelly loam, 15 to 30 percent**

**slopes.** This very deep, somewhat excessively drained soil is on outwash terraces and on slopes between the terraces. It formed in an admixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 400 to 1,200 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown very gravelly loam 4 inches thick. The upper 5 inches of the subsoil is strong brown extremely gravelly sandy loam. The lower 6 inches is strong brown very gravelly sandy loam. The substratum to a depth of 60 inches is brownish yellow and light yellowish brown very gravelly sand. The depth to very gravelly sand ranges from 13 to 24 inches. In some areas the surface layer is gravelly loam, very gravelly sandy loam, or cobbly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, has a substratum of very gravelly sand at a depth of 24 to 36 inches, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Sehome and Blethen soils and small areas of Barneston soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Barneston soil and very rapid in the substratum. Available water capacity is low or moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, red alder, and bigleaf maple. The common understory plants are Oregongrape, salal, western swordfern, western brackenfern, red huckleberry, and vine maple.

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, it is 118. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 158 cubic feet per acre per year, occurring at age 60.

The kind of equipment that can be used and the time of the year when it can be used normally are not restricted on this unit. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided

or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. A high soil temperature and a low content of moisture in the soil during the growing season cause a high rate of seedling mortality. If seed trees are available, natural reforestation of cutover areas by Douglas fir, red alder, and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVe.

**9-Barneston very gravelly loam, 30 to 60 percent slopes.** This very deep, somewhat excessively drained soil is on outwash terraces and terrace escarpments. It formed in an admixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 400 to 1,200 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. The surface layer is dark brown very gravelly loam 11 inches thick. The subsoil is dark yellowish brown extremely gravelly sandy loam 10 inches thick. The upper 16 inches of the substratum is dark yellowish brown extremely gravelly sand. The lower part to a depth of 60 inches is dark grayish brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 13 to 24 inches. In some areas the surface layer is gravelly loam, very gravelly sandy loam, or cobbly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, has a substratum of extremely gravelly sand at a depth of 24 to 36 inches, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Sehome and Blethen soils and small areas of Barneston soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Barneston soil and very rapid in the substratum. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It also is used as a source of aggregate.

Douglas fir is the main woodland species. Among the

trees of limited extent are western hemlock, western redcedar, red alder, and bigleaf maple. The common understory plants are Oregongrape, salal, western swordfern, western brackenfern, red huckleberry, and vine maple.

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, it is 118. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 158 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry. Soil creep is common on this unit.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir seedlings. A high soil temperature and a low content of moisture in the soil during the growing season cause a high rate of seedling mortality. If seed trees are available, natural reforestation of cutover areas by Douglas fir, red alder, and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

**10-Barnhardt gravelly loam, 0 to 5 percent slopes.**

This very deep, well drained soil is on outwash terraces. It formed in a mixture of volcanic ash, loess, and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 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 9 inches thick. The subsoil is yellowish brown extremely gravelly loam 12 inches thick. The upper 21 inches of the substratum is yellowish brown extremely gravelly sandy loam. The lower part to a depth of 60 inches is yellowish brown

extremely gravelly loam. In some areas the surface layer is loam, gravelly silt loam, or very gravelly loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil or is 30 to 60 inches deep to very gravelly sand.

Included in this unit are small areas of Clipper soils on the lower parts of the landscape, organic soils in depressions, Kickerville soils, and Barnhardt soils that have slopes of 5 to 10 percent. Included areas make up about 5 percent of the total acreage.

Permeability is moderately rapid in the Barnhardt soil. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture. It also is used as woodland, as a source of aggregate, and as a site for homes.

The main limitations in the areas used for hay and pasture are the moderate available water capacity and the gravelly surface layer. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common understory plants are salal, red huckleberry, Oregon grape, western swordfern, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 136. On the basis of a 50-year site curve, it is 106. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 139 cubic feet per acre per year, occurring at age 70.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Typically, the surface layer is loose when dry. As a result, the use of wheeled and tracked equipment is limited. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist, a high degree of puddling when the soil is wet, and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by

western hemlock occurs periodically. A high soil temperature and a low content of moisture in the soil during the growing season can cause seedling mortality. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

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

This map unit is in capability subclass IIIs.

#### **11-Bellingham silty clay loam, 0 to 2 percent slopes.**

This very deep, poorly drained soil is in depressions on terraces. It formed in an admixture of loess, alluvium, and glaciolacustrine deposits. The native vegetation is mainly trees and shrubs. Elevation is 20 to 200 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is very dark grayish brown silty clay loam 10 inches thick. The subsoil is very dark grayish brown, dark brown, and olive brown, mottled silty clay loam 14 inches thick. The substratum to a depth of 60 inches is grayish brown, mottled silty clay loam. In some areas the surface layer is silt loam, silty clay, or mucky silt loam. In other areas the soil has 20 to 35 percent clay or more than 60 percent clay in the subsoil or substratum, has a light colored surface layer, or has lenses of sand in the substratum.

Included in this unit are small areas of Skipopa, Everson, Whatcom, and Shalcar soils, partially drained Bellingham soils, and Bellingham soils having a surface layer that is 5 to 8 inches thick. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the Bellingham soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface from November through April. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion.

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

The main limitations in the areas used for hay and pasture are the high water table and the slow permeability. Proper stocking rates, pasture rotation, and restricted grazing when the soil is wet help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

The main limitations in the areas used as cropland

are the high water table and the slow permeability. The principal crop is corn silage. This unit also is suited to other climatically adapted crops. Some areas have been partially drained. Maintaining the drainage system permits fieldwork to be conducted earlier in the spring and increases yields. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping sequence help to maintain fertility and tilth.

Red alder is the main woodland species. Among the trees of limited extent are bigleaf maple, western redcedar, and western hemlock. The common understory plants are western swordfern, trailing blackberry, western brackenfern, salmonberry, and Douglas spirea.

On the basis of a 50-year site curve, the mean site index for red alder is 85. The highest average growth rate in unmanaged, even-aged stands of red alder is 92 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitations are the high water table and the shrink-

swell potential. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. Properly designing foundations and footings and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. The main limitations on sites for septic tank absorption fields are the seasonal high water table and the slow permeability. Installing absorption lines that are longer than normal helps to overcome these limitations.

This map unit is in capability subclass VIw.

**12-Birchbay silt loam, 0 to 3 percent slopes.** This very deep, moderately well drained soil is on wave-reworked glaciomarine drift plains. It formed in an admixture of volcanic ash and loess over glaciofluvial deposits and glaciomarine drift. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 350 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 180 days.

Typically, the surface layer is dark brown silt loam 8 inches thick. The upper 4 inches of the subsoil is dark brown silt loam. The lower 12 inches is dark yellowish brown gravelly silt loam. The upper 18 inches of the substratum is dark yellowish brown very gravelly sand. The lower part to a depth of 60 inches is light olive brown loam. The depth to very gravelly sand ranges from 14 to 32 inches. In some areas the surface layer is loam or gravelly silt loam. In other areas the soil is very gravelly sandy loam in the upper part of the substratum, has 15 to 35 percent pebbles in the lower part of the substratum, does not have very gravelly sand in the upper part of the substratum, or has less than 35 percent pebbles in the upper part of the substratum.

Included in this unit are small areas of Whitehorn, Labounty, Kickerville, Clipper, Hale, and Tromp soils, soils that are 30 to 40 inches deep to the lower part of the substratum, soils that are less than 14 inches deep to very gravelly sand, and Birchbay soils that have slopes of more than 3 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the upper part of the Birchbay soil, very rapid in the sandy upper part of the substratum, and slow in the loamy lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 2 to 4 feet from December through April. Runoff is very slow, and there is no hazard of erosion.

This unit is used mainly for hay and pasture. It also is used as cropland, as woodland, and as a site for homes.

Because of the nearly level slope, this soil remains saturated for longer periods than other Birchbay soils.

This saturation delays the use of equipment, increases the hazard of puddling, and shortens the effective growing season unless the soil is drained. If the unit is used for hay and pasture, proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

The main limitation in the areas used as cropland is the seasonal high water table. The principal crop is corn silage. This unit also is suited to other climatically adapted crops. Some areas have been partially drained. Maintaining the drainage system permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, grand fir, and paper birch. The common understory plants are vine maple, red huckleberry, salal, western swordfern, and Oregongrape.

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, it is 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 158 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Small amounts of rounded pebbles for road construction are readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitation affecting homesite development is the seasonal high water table. The wetness can be

reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. If used as a base for roads and streets, the soil can be mixed with the underlying sand and gravel, which can increase the strength and stability of the soil. In shallow excavations special retainer walls may be needed to keep cutbanks from caving.

The main limitations on sites for septic tank absorption fields are the seasonal high water table, the slow permeability, and a poor filtering capacity. Installing absorption lines that are longer than normal helps to overcome these limitations.

This map unit is in capability subclass IIw.

**13-Birchbay silt loam, 3 to 8 percent slopes.** This very deep, moderately well drained soil is on wave-reworked glaciomarine drift plains. It formed in an admixture of volcanic ash and loess over glaciofluvial deposits and glaciomarine drift. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 350 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 180 days.

Typically, the surface layer is dark brown silt loam 8 inches thick. The upper 4 inches of the subsoil is dark brown silt loam. The lower 12 inches is dark yellowish brown gravelly silt loam. The upper 18 inches of the substratum is dark yellowish brown very gravelly sand. The lower part to a depth of 60 inches is light olive brown loam. The depth to very gravelly sand ranges from 14 to 32 inches. In some areas the soil is very gravelly sandy loam in the upper part of the substratum, has 15 to 35 percent pebbles in the lower part of the substratum, does not have very gravelly sand in the upper part of the substratum, or has less than 35 percent pebbles in the upper part of the substratum.

Included in this unit are small areas of Whitehorn, Labounty, Kickerville, Everett, Clipper, Hale, and Tromp soils, soils that are 30 to 40 inches deep to the lower part of the substratum, soils that are less than 14 inches deep to very gravelly sand, and Birchbay soils that have slopes of more than 8 percent or less than 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Birchbay soil, very rapid in the sandy upper part of the substratum, and slow in the loamy lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 2 to 4 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture. It also is used as cropland, as woodland, and as a site for homes.

This unit is suited to hay and pasture. It has few limitations. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

The main limitation in the areas used as cropland is the seasonal high water table. The principal crop is corn silage. This unit also is suited to other climatically adapted crops. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water. In the areas that are drained, the dominant method of drainage is open ditches.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, grand fir, and paper birch. The common understory plants are vine maple, red huckleberry, salal, western swordfern, and Oregon grape.

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, it is 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 158 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Small amounts of rounded pebbles for road construction are readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitation affecting homesite development is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable

outlet is available. If used as a base for roads and streets, the soil can be mixed with the underlying sand and gravel, which can increase the strength and stability of the soil. In shallow excavations special retainer walls may be needed to keep cutbanks from caving.

The main limitations on sites for septic tank absorption fields are the seasonal high water table, the slow permeability, and a poor filtering capacity. These limitations can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour.

This map unit is in capability subclass IIe.

**14-Birchbay silt loam, 8 to 15 percent slopes.** This very deep, moderately well drained soil is on wave-reworked glaciomarine drift plains. It formed in an admixture of volcanic ash and loess over glaciofluvial deposits and glaciomarine drift. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 350 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 180 days.

Typically, the surface layer is dark brown silt loam 8 inches thick. The upper 4 inches of the subsoil is dark brown silt loam. The lower 12 inches is dark yellowish brown gravelly silt loam. The upper 18 inches of the substratum is dark yellowish brown very gravelly sand. The lower part to a depth of 60 inches is light olive brown loam. The depth to very gravelly sand ranges from 14 to 32 inches. In some areas the surface layer is loam or gravelly silt loam. In other areas the soil is very gravelly sandy loam in the upper part of the substratum, has 15 to 35 percent pebbles in the lower part of the substratum, does not have very gravelly sand in the upper part of the substratum, or has less than 35 percent pebbles in the upper part of the substratum.

Included in this unit are small areas of Whitehorn, Kickerville, Everett, and Clipper soils, soils that are 30 to 40 inches deep to the lower part of the substratum, seep areas, soils that are less than 14 inches deep to very gravelly sand, and Birchbay soils that have slopes of more than 15 percent or less than 8 percent. Included areas make up about 15 percent, of the total acreage.

Permeability is moderate in the upper part of the Birchbay soil, very rapid in the sandy upper part of the substratum, and slow in the loamy lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 2 to 4 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

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

The main limitation in the areas used for hay and pasture is the hazard of erosion during periods of reestablishment. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, grand fir, and paper birch. The common understory plants are vine maple, red huckleberry, salal, western swordfern, and Oregongrape.

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, it is 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 158 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Small amounts of rounded pebbles for road construction are readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitation is the seasonal high water table. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitations on sites for septic tank absorption fields are the seasonal high water table, the slow permeability, and a poor filtering capacity. Effluent from absorption fields can surface in downslope areas and create a hazard to health.

This map unit is in capability subclass IIIe.

**15-Blainegate silty clay, 0 to 1 percent slopes.** This very deep, poorly drained soil is on marine terraces. It formed in marine deposits. The native vegetation is mainly trees and shrubs. Elevation is 10 to 100 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 180 days.

Typically, the surface layer is very dark grayish brown, mottled silty clay 9 inches thick. The subsoil is dark gray, mottled clay 18 inches thick. The upper 18 inches of the substratum is gray, mottled clay. The lower part to a depth of 60 inches is light brownish gray, mottled clay. In some areas the surface layer is silty clay loam. In other areas the substratum contains lenses of loamy or sandy material or is 35 to 60 percent clay.

Included in this unit are small areas of Skipopa, Whatcom, Whitehorn, Shalcar, and Yelm soils and drained Blainegate soils. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Blainegate soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface from November through June. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion.

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

The main limitations in the areas used for hay and pasture are the seasonal high water table and the very slow permeability. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. The water table limits the use of this unit to grasses unless a drainage system is installed. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

The main limitations in the areas used as cropland are the seasonal high water table and the very slow permeability. The principal crop is corn silage. This unit also is suited to other climatically adapted crops. Tile drains and field ditches are needed to lower the high water table if deep-rooted plants are to be grown. Some areas have been partially drained. Maintaining the drainage system permits fieldwork to be conducted earlier in the spring and increases yields. Drainage tiles should be closely spaced because of the very slow permeability. Tile drains and open drains can be used to lower the water table if a suitable outlet is available. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches,

which remove excess water. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping sequence help to maintain fertility and tilth.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar and western hemlock. The common understory plants are western swordfern, western brackenfern, trailing blackberry, salmonberry, and Douglas spirea.

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 in unmanaged, even-aged stands of red alder is about 92 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads may be impassable during rainy periods. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitations are the seasonal high water table and the shrink-swell potential. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. Properly designing foundations and footings and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. The main limitations on sites for septic tank absorption fields are the seasonal high water table and

the very slow permeability. Installing absorption lines that are longer than normal helps to overcome these limitations.

This map unit is in capability subclass VIw.

**16-Blainegate-Urban land complex, 0 to 1 percent slopes.** This map unit is on marine terraces. The native vegetation is mainly trees and shrubs. Elevation is 10 to 100 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 180 days.

This unit is 50 percent Blainegate silty clay loam and 30 percent Urban land. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Skipopa, Whatcom, Whitehorn, and Yelm soils. Included areas make up about 20 percent of the total acreage.

The Blainegate soil is very deep and poorly drained. It formed in marine deposits. Typically, the surface layer is very dark grayish brown, mottled silty clay 9 inches thick. The subsoil is dark gray, mottled clay 18 inches thick. The upper 18 inches of the substratum is gray, mottled clay. The lower part to a depth of 60 inches is light brownish gray, mottled clay. In some areas the surface layer is silty clay. In other areas the substratum has lenses of loamy or sandy material or has 35 to 60 percent clay.

Permeability is very slow in the Blainegate soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface from November through June. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion.

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

The Blainegate soil is used for lawns, gardens, or parks.

If this unit is used for homesite development, the main limitations are the seasonal high water table and the shrink-swell potential. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. Properly designing foundations and footings and diverting runoff away from the buildings help to prevent the structural damage caused by shrinking and swelling. The main limitations on sites for septic tank absorption fields are the seasonal high water table and the very slow permeability. Installing absorption lines

that are longer than normal helps to overcome these limitations.

The Blainegate soil is in capability subclass VIw. The Urban land is in capability subclass VIIIs.

#### **17-Blethen gravelly loam, 5 to 15 percent slopes.**

This very deep, well drained soil is on side slopes and toe slopes of foothills. It formed in colluvium, glacial till, and slope alluvium with an admixture of volcanic ash and loess. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,400 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown gravelly loam. The upper 8 inches of the subsoil is dark brown gravelly loam. The lower 6 inches is yellowish brown very gravelly loam. The substratum to a depth of 60 inches is brown and yellowish brown very gravelly loam. In some areas the surface layer is very gravelly loam, gravelly silt loam, or very gravelly silt loam. In other areas the soil has less than 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep to dense glacial till or bedrock.

Included in this unit are small areas of Barneston, Chuckanut, Heisler, Nati, Sehome, and Vanzandt soils, slump areas, stony areas, and Blethen soils that have slopes of more than 15 percent or less than 5 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Blethen soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture and as a site for homes.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are salal, Oregon grape, vine maple, red huckleberry, western swordfern, longtube twinflower, and trailing blackberry.

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, it is 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 157 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of

wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. A high soil temperature and a low moisture content in the soil during the growing season can cause seedling mortality. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock and Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation in the areas used for hay and pasture is the hazard of erosion during periods of reestablishment. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff during periods of reestablishment.

The main limitation affecting homesite development is the slope. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope. The slope affects the installation of septic tank absorption fields. The absorption lines should be installed on the contour.

This map unit is in capability subclass IIIe.

#### **18-Blethen gravelly loam, 15 to 30 percent slopes.**

This very deep, well drained soil is on side slopes and toe slopes of foothills. It formed in colluvium, glacial till, and slope alluvium with an admixture of volcanic ash and loess. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,400 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of

needles, leaves, and twigs 1 inch thick. When mixed to a depth of 6 inches, the surface layer is dark brown gravelly loam. The upper 12 inches of the subsoil is dark brown very cobbly loam. The lower 23 inches is dark yellowish brown very cobbly loam. The substratum to a depth of 60 inches is olive brown very cobbly loam. In some areas the surface layer is very gravelly loam, gravelly silt loam, or very gravelly silt loam. In other areas the soil has less than 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep to dense glacial till or bedrock.

Included in this unit are small areas of Barneston, Chuckanut, Heisler, Nati, Sehome, and Vanzandt soils, soils that have serpentinitic mineralogy, slump areas, stony areas, and Blethen soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Blethen soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are salal, Oregongrape, vine maple, red huckleberry, western swordfern, longtube twinflower, and trailing blackberry.

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, it is 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 157 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Cut and fill slopes tend to slump when wet. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas. Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment and mortality are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. A high soil temperature and a low moisture content in the soil during the growing season can cause seedling mortality. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock and Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVe.

#### **19-Blethen gravelly loam, 30 to 60 percent slopes.**

This very deep, well drained soil is on side slopes of foothills. It formed in colluvium, glacial till, and slope alluvium with an admixture of volcanic ash and loess. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,400 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown gravelly loam. The upper 5 inches of the subsoil is dark brown gravelly loam. The lower 7 inches is dark yellowish brown very gravelly loam. The substratum to a depth of 60 inches is dark yellowish brown and olive brown extremely gravelly sandy loam. In some areas the surface layer is gravelly loam, gravelly silt loam, or very gravelly silt loam. In other areas the soil has less than 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep to dense glacial till or bedrock.

Included in this unit are small areas of Barneston, Chuckanut, Heisler, Nati, Sehome, and Vanzandt soils, soils that have serpentinitic mineralogy, slump areas, stony areas, rock outcrop, and Blethen soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Blethen soil. Available water capacity is high. The effective rooting depth is 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. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are salal,

Oregongrape, vine maple, red huckleberry, western swordfern, longtube twinflower, and trailing blackberry.

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, it is 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 157 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. Cable yarding systems generally are used on this unit. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Unsurfaced roads are slippery and soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is generally not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. A high soil temperature and a low moisture content in the soil during the growing season can cause seedling mortality. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock and Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

**20-Blethen very bouldery loam, 5 to 40 percent slopes.** This very deep, well drained soil is on landslides and toe slopes of foothills. It formed in colluvium, glacial till, and slope alluvium with an admixture of volcanic ash and loess. The native vegetation is mainly conifers and shrubs. Elevation is 500 to 1,400 feet. The average annual precipitation is

about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown very bouldery loam. The upper 3 inches of the subsoil is dark brown extremely gravelly loam. The lower 19 inches is dark yellowish brown extremely gravelly loam. The substratum to a depth of 60 inches is olive brown and light olive brown extremely cobbly loam. In some areas the surface layer is bouldery loam, very stony loam, or very gravelly loam. In other areas the depth to bedrock is 40 to 60 inches.

Included in this unit are small areas of Chuckanut, Nati, and Squalicum soils, wet areas, landslides, and Blethen soils that have slopes of more than 40 percent or less than 5 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Blethen soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are red huckleberry, Oregongrape, western swordfern, salal, vine maple, longtube twinflower, trailing blackberry, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 144. On the basis of a 50-year site curve, it is estimated to be 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 150 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the surface boulders and the slope. The trees can break if they are felled on the boulders, and yarding operations can be hindered by the boulders. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Steep skid trails and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and mortality are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. Because of the boulders, planting seedlings

by hand is difficult. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock and Douglas fir occurs periodically. A high soil temperature and a low moisture content in the soil during the growing season can cause seedling mortality. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VI<sub>s</sub>.

**21-Borosaprists, 0 to 2 percent slopes.** These very deep, very poorly drained soils are in depressions on mountains. They formed in mixed organic material consisting of mosses, forbs, and shrubs over mineral material. The native vegetation is mainly shrubs and forbs. Elevation is 1,000 to 3,000 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 110 days.

No single profile is representative of this map unit. In one of the more commonly observed ones, however, the surface layer is very dark brown muck about 15 inches thick. The next 45 inches is very dark brown muck. The depth to mineral soil material ranges from 20 to more than 60 inches. After rubbing, the fiber content ranges from 5 to 15 percent. Reaction ranges from extremely acid to medium acid. In some areas the surface layer is hemic material.

Included in this unit are small areas of mineral soils that are ponded. Included areas make up about 5 percent of the total acreage.

Permeability is moderate in the Borosaprists. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface throughout the year. Runoff is ponded, and there is no hazard of erosion. This unit is used for wildlife habitat.

This map unit is in capability subclass VII<sub>w</sub>.

**22-Briscot silt loam, drained, 0 to 2 percent slopes.** This very deep, poorly drained soil is on flood plains. It has been artificially drained. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is 20 to 50 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark grayish brown silt loam 9 inches thick. The underlying material to a depth of 60 inches is dark grayish brown, gray, and light brownish gray, mottled, stratified silt loam, very fine sandy loam, fine sand, and fine sandy loam. In some

areas the surface layer is very fine sandy loam, fine sandy loam, or loam. In other areas the soil has a dark brown surface layer, a silt loam underlying layer, or a sandy loam underlying layer.

Included in this unit are small areas of Mt. Vernon and Puyallup soils, undrained Briscot soils, Shalcar soils in depressions, and small bodies of water. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Briscot soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 3 feet from November through April. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion. Downstream from Lynden, this soil is subject to occasional brief periods of flooding from December through February.

This unit is used mainly for hay and pasture or as cropland. The included undrained Briscot soils are used as woodland.

The main limitation in the areas used for hay and pasture is the seasonal high water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. In areas where the drainage system is not maintained or in areas which do not have drainage, the water table limits the use of this unit to grasses. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

This soil is suited to most crops commonly grown in the survey area if adequate drainage systems are maintained. These crops are peas, sweet corn, beans, and small grain. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping sequence help to maintain fertility and tilth. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Tile drains and field ditches should be maintained. They permit field operations to be conducted earlier in the spring and increase yields of perennial crops. In summer, irrigation is required for maximum production.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, and black cottonwood. The common understory plants are salmonberry, Douglas spirea, rose, stinging nettle, and sedges.

On the basis of a 50-year site curve, the mean site index for red alder is 95. The highest average growth rate in unmanaged, even-aged stands of red alder is 109 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are

the occasional flooding and the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The high water table and the flooding hinder root respiration and thus result in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitations are the high water table and the hazard of flooding. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the seasonal high water table and the hazard of flooding. Installing absorption lines that are longer than normal and installing flood-control structures help to overcome these limitations.

This map unit is in capability subclass IIw.

**23-Briscot, Oridia, and Sumas soils, 0 to 2 percent slopes.** This unit formed in alluvium on flood plains. The native vegetation is mainly trees and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 55 percent Briscot silt loam, 20 percent Oridia silt loam, and 15 percent Sumas silt loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of drained Briscot, Oridia, and Sumas soils and bodies of water. Included areas make up about 10 percent of the total acreage.

The Briscot soil is very deep and poorly drained. Typically, the surface is covered with a mat of leaves and twigs 2 inches thick. The upper 4 inches of the surface layer is very dark grayish brown silt loam. The lower 8 inches is olive brown silt loam. The upper 25 inches of the substratum is dark grayish brown and brown, mottled loam. The lower part to a depth of 60 inches is fine sandy loam. It is variegated but is dominantly dark grayish brown. In some areas the soil has sand in the substratum or has stratified sand and silt in the substratum.

Permeability is moderate in the Briscot soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface from November through May. This soil is subject to frequent, brief periods of flooding from November through April. Channeling and deposition are common along streambanks.

The Oridia soil is very deep and poorly drained. Typically, the surface layer is very dark grayish brown silt loam 12 inches thick. The upper 12 inches of the underlying material is dark grayish brown, mottled silt loam. The next 16 inches is gray, mottled silt loam. The lower part to a depth of 60 inches is gray silt loam. In some areas the soil has stratified sand and silt in the substratum or has 18 to 35 percent clay in the substratum.

Permeability is moderate in the Oridia soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface from November through May. This soil is subject to frequent, brief periods of flooding from November through April. Channeling and deposition are common along streambanks.

The Sumas soil is very deep and poorly drained. Typically, the surface layer is dark brown silt loam 8 inches thick. The upper 10 inches of the underlying material is grayish brown, mottled silt loam. The lower part to a depth of 60 inches is dominantly very dark grayish brown sand.

Permeability is moderate in the upper part of the Sumas soil and rapid in the lower part of the underlying material. Available water capacity is moderate. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface from November through May. This soil is subject to frequent, brief periods of flooding from November through April. Channeling and depositions are common along streambanks.

This unit is used as woodland. Red alder is the main

woodland species. Among the trees of limited extent are western redcedar and black cottonwood. The common understory plants are salmonberry, Douglas spirea, rose, stinging nettle, and sedges.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the frequent flooding and the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable and uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soils are moist and a high degree of puddling when the soils are wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table and the flooding hinder root respiration and thus result in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are frequently subject to windthrow when the soils are wet and winds are strong.

If this unit is used for homesite development, the main limitations are the seasonal high water table and the hazard of flooding. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water. It also can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the seasonal high water table and the hazard of flooding. Installing the absorption field in fill approved by the health district helps to compensate for the moderate permeability in the Sumas soil. Flood-control structures are needed.

The Briscot, Oridia, and Sumas soils are in capability subclass VIw.

**24-Chuckanut loam, 3 to 8 percent slopes.** This very deep, well drained soil is on toe slopes of foothills. It formed in a mixture of volcanic ash and colluvium derived from glacial drift and sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 250 to 450 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 160 days.

Typically, the surface layer is dark brown loam 10 inches thick. The upper 2 inches of the subsoil is olive brown sandy loam. The lower 12 inches is dark brown gravelly loam. The substratum to a depth of 60 inches is olive brown gravelly sandy loam with 60 percent weathered rock fragments. In some areas the surface layer is sandy loam or silt loam. In other areas the soil has 20 to 50 percent weathered rock fragments in the subsoil or is 40 to 60 inches deep to sandstone.

Included in this unit are small areas of Squalicum, Briscot, and Puyallup soils and small areas of Chuckanut soils that have slopes of more than 8 percent or less than 3 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Chuckanut soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture. It also is used as woodland and as a site for homes.

This unit is suited to hay and pasture. It has few limitations. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition. This unit also is suited to other climatically adapted crops. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are western swordfern, red huckleberry, Oregongrape, western brackenfern, and salal.

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, it is 130. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 184 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high

degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is suited to homesite development. It has few limitations. Moderate erosion is likely to occur on unprotected construction sites. Installing the absorption field in fill approved by the health district helps to compensate for the moderate permeability of this soil.

This map unit is in capability subclass IIe.

**25-Chuckanut loam, bedrock substratum, 5 to 15 percent slopes.** This deep, well drained soil is on toe slopes of foothills. It formed in a mixture of volcanic ash and colluvium derived from glacial drift and sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 1,400 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown loam 6 inches thick. The upper 4 inches of the subsoil is dark yellowish. brown loam. The lower 21 inches is light olive brown gravelly loam. The substratum is light olive brown gravelly loam 17 inches thick. It is underlain by sandstone at a depth of 48 inches. The depth to sandstone ranges from 40 to 60 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is gravelly loam or sandy loam. In other areas the soil is more than 60 inches deep to sandstone or is 40 to 60 inches deep to siltstone or conglomerate.

Included in this unit are small areas of Nati and Squalicum soils, Bellingham soils in depressions, and Chuckanut soils that have slopes of more than 15 percent or less than 5 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Chuckanut soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture and as a site for homes.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and Pacific madrone. The common understory plants are western swordfern, red huckleberry, Oregongrape, western brackenfern, and salal.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 161. On the basis of a 50-year site curve, it is 119. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Sandstone, a poor-quality rock for road construction, is readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation in the areas used for hay and pasture is the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and water erosion during periods of reestablishment.

The main limitation affecting homesite development is the slope. The main limitations on sites for septic tank absorption fields are the depth to bedrock, the moderate permeability, and the slope. These limitations can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope.

This map unit is in capability subclass IIIe.

**26-Chuckanut loam, bedrock substratum, 15 to 30 percent slopes.** This deep, well drained soil is on toe slopes and side slopes of foothills. It formed in a mixture of volcanic ash and colluvium derived from glacial drift and sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 1,400 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown loam 6 inches thick. The upper 4 inches of the subsoil is dark yellowish brown loam. The lower 21 inches is light olive brown gravelly loam. The substratum is light brown gravelly loam 17 inches thick. It is underlain by sandstone at a depth of 48 inches. The depth to sandstone ranges from 40 to 60 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is gravelly loam or sandy loam. In other areas the soil is more than 60 inches deep to sandstone or is 40 to 60 inches deep to siltstone or conglomerate.

Included in this unit are small areas of Nati and Squalicum soils, Bellingham soils in depressions, and Chuckanut soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Chuckanut soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and Pacific madrone. The common understory plants are western swordfern, red huckleberry, Oregongrape, western brackenfern, and salal.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 161. On the basis of a 50-year site curve, it is 119. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a

moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVe.

**27-Chuckanut loam, bedrock substratum, 30 to 60 percent slopes.** This deep, well drained soil is on side slopes of foothills. It formed in a mixture of volcanic ash and colluvium derived from glacial drift and sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 1,400 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown loam 3 inches thick. The subsoil is dark yellowish brown gravelly loam 14 inches thick. The substratum is yellowish brown gravelly sandy loam 35 inches thick. Sandstone is at a depth of about 52 inches. The depth to sandstone ranges from 40 to 60 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is gravelly loam or sandy loam. In other areas the soil has a thicker surface layer, is more than 60 inches deep to sandstone, or is 40 to 60 inches deep to siltstone or conglomerate.

Included in this unit are small areas of Nat! and Squalicum soils, Bellingham soils in depressions, and Chuckanut soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Chuckanut soil. Available water capacity is high. The 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. Among the trees of limited extent are western hemlock, red alder, western redcedar, and Pacific madrone. The common understory plants are western swordfern, red huckleberry, Oregon grape, western brackenfern, and salal.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 161. On the basis of a 50-year site curve, it is 119. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 171 cubic feet per acre per year, occurring at age 65.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

**28-Chuckanut-Shalcar complex, 0 to 15 percent slopes.** This map unit is on toe slopes of foothills and landslides. Slopes are hummocky. The Chuckanut soil

is on slopes, and the Shalcar soil is in depressions. The areas of Shalcar soil are irregular in shape and are 0.25 acre to 5 acres in size. The native vegetation is mainly conifers and shrubs on the Chuckanut soil and shrubs and forbs on the Shalcar soil. Elevation is 250 to 500 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 160 days.

This unit is 75 percent Chuckanut loam and 10 percent Shalcar muck. The Chuckanut soil has slopes of 3 to 15 percent, and the Shalcar soil has slopes of 0 to 2 percent. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Nati soils on ridges of foothills; Bellingham soils in depressions; deep, organic soils in depressions; Chuckanut soils that have slopes of more than 15 percent; and bouldery areas. Included areas make up about 15 percent of the total acreage.

The Chuckanut soil is very deep and well drained. It formed in a mixture of volcanic ash and colluvium derived from glacial drift and sandstone. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. The surface layer is very dark brown loam 4 inches thick. The upper 11 inches of the subsoil is dark yellowish brown gravelly loam. The lower 6 inches is olive brown gravelly loam. The upper 10 inches of the substratum is olive brown gravelly loam. The lower part to a depth of 60 inches is dark grayish brown gravelly loam. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is sandy loam or silt loam. In other areas the soil has sandstone at a depth of 40 to 60 inches.

Permeability is moderate in the Chuckanut soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

The Shalcar soil is very deep and very poorly drained. It formed in mixed organic material consisting of mosses, forbs, and shrubs over alluvium. Typically, the surface layer is very dark brown muck 18 inches thick. The underlying material to a depth of 60 inches is dark gray loam. In some areas the surface layer is mucky silt loam. In other areas the underlying material is silt loam or sandy loam.

Permeability is moderate in the Shalcar soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface from October through May. Runoff is ponded, and there is no hazard of erosion.

The Chuckanut soil is used mainly as woodland. It also is used as a site for homes. The Shalcar soil is used for wildlife habitat.

Douglas fir is the main woodland species on the Chuckanut soil. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are western swordfern, red huckleberry, Oregongrape, western brackenfern, and salal.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 173 on the Chuckanut soil. On the basis of a 50-year site curve, it is estimated to be 130. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 184 cubic feet per acre per year, occurring at age 60.

Red alder is the main woodland species on the Shalcar soil. Among the trees of limited extent are western redcedar, western hemlock, lodgepole pine, and Sitka spruce. The common understory plants include salmonberry, Douglas spirea, rose, stinging nettle, and sedges.

On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 85 on the Shalcar soil. The highest average growth rate in unmanaged, even-aged stands of red alder is about 92 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the ponding on the Shalcar soil, the muddiness caused by seasonal wetness on the Chuckanut soil, and the hummocky topography. The ponding hinders the use of ground equipment and hinders timber harvesting. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soils are moist and a moderate degree of puddling when the soils are wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production on the Chuckanut soil. Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns on the Shalcar soil. Reforestation can be accomplished by planting Douglas fir or red alder seedlings on the Chuckanut soil and western redcedar or red alder seedlings on the Shalcar soil. The ponding on the Shalcar soil makes planting seedlings by hand difficult. The high water table on the Shalcar soil hinders root respiration and thus results in a low seedling survival rate. If seed trees are available, natural reforestation of cutover areas by red alder

occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

Because the rooting depth is restricted by the high water table, trees on the Shalcar soil are frequently subject to windthrow when the soil is wet and winds are strong.

The main limitations affecting homesite development are the slope of the Chuckanut soil and the high water table and low strength of the Shalcar soil. Effluent from absorption fields can surface in downslope areas and create a health hazard. The moderate permeability in the Chuckanut soil and the high water table in the Shalcar soil increase the likelihood that the absorption field will fail.

The Chuckanut soil is in capability subclass IIle. The Shalcar soil is in capability subclass VIw.

**29-Chuckanut-Urban land complex, 5 to 20 percent slopes.** This map unit is on toe slopes of foothills. The native vegetation is mainly conifers and shrubs. Elevation is 20 to 500 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 50 percent Chuckanut loam and 35 percent Urban land. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Nati, Everett, Squalicum, and Whatcom soils, Bellingham and Labounty soils in depressions, and Chuckanut soils that have slopes of more than 20 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

The Chuckanut soil is very deep and well drained. It formed in a mixture of volcanic ash and colluvium derived from glacial drift and sandstone. When mixed to a depth of 6 inches, the surface layer is dark brown loam. The upper 4 inches of the subsoil is dark yellowish brown gravelly loam. The lower 21 inches is light olive brown gravelly loam. The substratum is light olive brown gravelly loam 17 inches thick. It is underlain by sandstone at a depth of 48 inches. The depth to sandstone ranges from 40 to 60 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is gravelly loam or sandy loam. In other areas the soil is more than 60 inches deep to sandstone.

Permeability is moderate in the Chuckanut soil.

Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

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

The Chuckanut soil is used for lawns, gardens, parks, or vacant lots. It is highly erodible during construction and on cut and fill slopes.

If this unit is used for homesite development, the main limitation is the slope. The main limitations on sites for septic tank absorption fields are the slope, the moderate permeability, and the depth to bedrock. These limitations can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope.

The Chuckanut soil is in capability subclass IIIe. The Urban land is in capability subclass VIIIs.

**30-Clendenen gravelly silt loam, 5 to 30 percent slopes.** This shallow, moderately well drained soil is on mountain shoulder slopes and back slopes. It formed in a mixture of volcanic ash, loess, and colluvium and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 3,200 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 period is about 100 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 7 inches thick. When mixed to a depth of 5 inches, the surface layer is strong brown gravelly silt loam. The subsoil is strong brown very gravelly silt loam 11 inches thick. Dense glacial till that crushes to very gravelly loam is at a depth of 16 inches. The depth to dense glacial till ranges from 14 to 20 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is very gravelly silt loam, silt loam, or gravelly loam. In other areas the soil has dunite rock fragments in the subsoil or is 20 to 30 inches deep to dense glacial till.

Included in this unit are small areas of Edfro, Diobsud, Crinker, and Hinker soils, soils that are shallow to bedrock or very shallow to dense glacial till, and Clendenen soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Clendenen soil and very slow in the dense glacial till. Available water capacity is low. The 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 from November through June.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, mountain hemlock, and western redcedar. The common understory plants are tall blue huckleberry, bunchberry dogwood, western brackenfern, and deer fern.

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, it is estimated to be 75. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 151 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from November through May. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and fire breaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. The seasonal wetness hinders root respiration and thus results in a low seedling survival rate. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the dense glacial till, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

### **31-Clipper silt loam, drained, 0 to 2 percent slopes.**

This very deep, somewhat poorly drained soil is in depressions on outwash terraces and outwash plains. It has been artificially drained. It formed in an admixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly trees and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is very dark grayish brown silt loam 9 inches thick. The upper 9 inches of the subsoil is grayish brown and gray, mottled silt loam. The lower 12 inches is grayish brown, gray, and yellowish brown, mottled gravelly sandy loam. The substratum to a depth of 60 inches is dark grayish brown and grayish brown, mottled very gravelly loamy sand. The depth to very gravelly loamy sand or sand ranges from 14 to 30 inches. In some areas the surface layer is loam or gravelly silt loam. In other areas the soil has a substratum of very gravelly sandy loam, gravelly sand, or gravelly sandy loam.

Included in this unit are small areas of Birchbay, Kickerville, and Whitehorn soils, undrained Clipper soils, and soils that are similar to the Clipper soil but have 18 to 25 percent clay in the subsoil or have a hardpan of glaciomarine drift at a depth of 40 to 60 inches. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Clipper soil and rapid in the substratum. Available water capacity is moderate. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 2 to 4 feet from November through April. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion.

This unit is used mainly for hay and pasture or as cropland. It also is used as woodland and as a site for homes. The included undrained Clipper soils are used as woodland.

The main limitations for hay and pasture are the seasonal high water table and the moderate available water capacity. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. The water table limits the use of this unit to grasses unless a drainage system is installed. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

The main limitations in the areas used as cropland are the seasonal high water table and the moderate available water capacity. The principal crops are small grain and corn silage. This unit is well suited to most

crops commonly grown in the survey area if adequate drainage systems are maintained. It also is suited to other climatically adapted crops.

During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Tile drains and field ditches should be maintained. They permit field operations to be conducted earlier in the spring and increase yields of perennial crops. Most crops common to the area can be grown if the drainage system is adequate. In summer, irrigation is required for maximum production.

Red alder is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and Douglas fir. The common understory plants are salmonberry, western brackenfern, red huckleberry, western swordfern, trailing blackberry, and sweetscented bedstraw.

On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 95. The highest average growth rate in unmanaged, even-aged stands of red alder is about 109 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. The high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder 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, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

The main limitation affecting homesite development is the seasonal high water table. The wetness can be

reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitations on sites for septic tank absorption fields are the seasonal high water table and a poor filtering capacity. Installing absorption lines that are longer than normal helps to overcome these limitations. If used as a base for roads and streets, the soil can be mixed with the underlying sand and gravel, which can increase the strength and stability of the soil.

This map unit is in capability subclass IIw.

**32-Comar silt loam, 5 to 15 percent slopes.** This deep, moderately well drained soil is on toe slopes of foothills. It formed in a mixture of volcanic ash and slope alluvium and colluvium derived from siltstone and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 1,500 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is very dark grayish brown silt loam 5 inches thick. The subsoil is dark yellowish brown silt loam 16 inches thick. The substratum is light olive brown silt loam 19 inches thick. Siltstone is at a depth of about 40 inches. The depth to siltstone ranges from 40 to 60 inches. In some areas the soil has a gravelly subsoil, is more than 60 inches deep to siltstone, or is 40 to 60 inches deep to sandstone.

Included in this unit are small areas of Nati, Sehome, and Squalicum soils, Bellingham soils in depressions, bouldery areas, and Comar soils that have slopes of more than 15 percent or less than 5 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Comar soil. Available water capacity is moderate. The effective rooting depth is 40 to 60 inches. A seasonal high water table fluctuates in depth from 1.5 to 3.5 feet in January and February. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture and as a site for homes.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are vine maple, western swordfern, red huckleberry, salal, western brackenfern, and Oregonrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 148. On the basis of a 50-year site curve, it is 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 156

cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Siltstone, a poor-quality rock for road construction, is readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation in the areas used for hay and pasture is the hazard of erosion during periods of reestablishment. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff during periods of reestablishment.

The main limitations affecting homesite development are the seasonal high water table and the slope. The deep cuts needed to provide essentially level building sites can expose bedrock. The main limitations on sites for septic tank absorption fields are the seasonal high water table and the moderately slow permeability. These limitations can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour. The slope affects the installation of septic tank absorption fields.

This map unit is in capability subclass IIIe.

**33-Comar silt loam, 15 to 30 percent slopes.** This deep, moderately well drained soil is on toe slopes and side slopes of foothills. It formed in a mixture of volcanic ash and slope alluvium and colluvium derived from siltstone and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 1,500 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of

needles, leaves, and twigs 2 inches thick. The surface layer is very dark grayish brown silt loam 5 inches thick. The subsoil is dark yellowish brown silt loam 16 inches thick. The substratum is light olive brown silt loam 19 inches thick. It has 15 percent weathered rock fragments. Siltstone is at a depth of about 40 inches. The depth to siltstone ranges from 40 to 60 inches. In some areas the soil has a gravelly subsoil, is more than 60 inches deep to siltstone, or is 40 to 60 inches deep to sandstone or conglomerate.

Included in this unit are small areas of Nati, Sehome, and Squalicum soils, Bellingham soils in depressions, bouldery areas, and Comar soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Comar soil. Available water capacity is moderate. The effective rooting depth is 40 to 60 inches. A seasonal high water table fluctuates in depth from 1.5 to 3.5 feet in January and February. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are vine maple, western swordfern, red huckleberry, salal, western brackenfern, and Oregon grape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 148. On the basis of a 50-year site curve, it is 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 156 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Siltstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds

than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVE.

**34-Comar silt loam, 30 to 60 percent slopes.** This deep, moderately well drained soil is on toe slopes and side slopes of foothills. It formed in a mixture of volcanic ash and slope alluvium and colluvium derived from siltstone and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 1,500 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 5 inches thick. The surface layer is dark brown silt loam 5 inches thick. The subsoil is brown silt loam 11 inches thick. The substratum is light olive brown silt loam 28 inches thick. Siltstone is at a depth of about 44 inches. The depth to siltstone ranges from 40 to 60 inches. In some areas the soil is 40 to 60 inches deep to sandstone or conglomerate.

Included in this unit are small areas of Nati, Sehome, and Squalicum soils, Bellingham soils in depressions, bouldery areas, and Comar soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Comar soil. Available water capacity is moderate. The effective rooting depth is 40 to 60 inches. A seasonal high water table fluctuates in depth from 1.5 to 3.5 feet in January and February. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are vine maple, western swordfern, red huckleberry, salal, western brackenfern, and Oregon grape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 148. On the basis of a 50-year site curve, it is 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 156 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is

harvested, the slope restricts the use of wheeled and tracked equipment in skidding operations. Cable yarding systems generally are safer and disturb the surface less extensively. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Siltstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

**35-Crinker very channery silt loam, 30 to 60 percent slopes.** This moderately deep, well drained soil is on high mountain back slopes and shoulder slopes. It formed in an admixture of volcanic ash and slope alluvium, colluvium, and glacial till derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 100 days.

Typically, the surface is covered with a mat of decomposed needles, leaves, and twigs 6 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown very channery silt loam. The upper 3 inches of the subsoil is organic stained, strong brown very channery silt loam. The lower 15 inches is yellowish

brown very channery silt loam. Phyllite is at a depth of about 24 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is channery silt loam or channery loam. In other areas the soil has a less developed subsoil, has less than 6 percent organic carbon throughout the subsoil, is 14 to 20 or 40 to 60 inches deep to phyllite, or does not have the subsurface layer.

Included in this unit are small areas of Wollard, Diobsud, Clendenen, and Saar soils, Rock outcrop, and Crinker soils that have slopes of more than 60 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Crinker soil. Available water capacity also is moderate. The 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. Among the trees of limited extent is Pacific silver fir. The common understory plants are tall blue huckleberry, salmonberry, bunchberry dogwood, western brackenfern, and deer fern.

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, it is 83. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 178 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the hazard of erosion, and the slope. During an average year, the snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Phyllite, a poor-quality rock for road construction, is readily available. Extra rock is needed to maintain a stable, uniform road surface. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable

yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, noble fir, or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

### **36-Cupples gravelly loam, 5 to 30 percent slopes.**

This moderately deep, moderately well drained soil is on mountain back slopes and plateaus. It formed in a mixture of volcanic ash and loess over glacial till. The native vegetation is mainly conifers and shrubs. 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 period is about 120 days.

Typically, the surface is covered with a mat of needles and twigs 7 inches thick. When mixed to a depth of 10 inches, the surface layer is dark brown gravelly loam. The subsoil is olive brown and dark yellowish brown very gravelly loam 20 inches thick. Dense glacial till that crushes to very gravelly sandy loam is at a depth of 30 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly silt loam. In other areas the soil has more than 35 percent weathered rock fragments within the subsoil, has less than 35 percent rock fragments within the subsoil, is 40 to 60 inches deep to dense glacial till, or has a less developed subsoil.

Included in this unit are small areas of Revel, Welcome, Rinker, and Oakes soils, soils that are less than 30 inches deep to dense glacial till, and Cupples soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Cupples soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from December through

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. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are western swordfern, deer fern, red huckleberry, western brackenfern, longtube twinflower, and vine maple.

On the basis of a 100-year site curve, the mean site index for western hemlock is 143. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 224 cubic feet per acre per year, occurring at age 50. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 154. On the basis of a 50-year site curve, it is estimated to be 118. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 163 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the muddiness caused by seasonal wetness and occasional snowpack. During an average year, the snowpack limits the use of equipment and restricts access from January through March. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established. .

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are available, natural reforestation of cutover

areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass IVe.

### **37-Cupples gravelly loam, 30 to 60 percent slopes.**

This moderately deep, moderately well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash and loess over glacial till. The native vegetation is mainly conifers and shrubs. 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 period is about 120 days.

Typically, the surface is covered with a mat of needles and twigs 6 inches thick. When mixed to a depth of 6 inches, the surface layer is grayish brown gravelly loam. The subsoil is dark brown and yellowish brown very gravelly loam 32 inches thick. Dense glacial till that crushes to very gravelly sandy loam is at a depth of 38 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly silt loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to dense glacial till, or has a less developed subsoil.

Included in this unit are small areas of Revel, Welcome, Rinker, and Oakes soils, soils that are less than 20 inches deep to dense glacial till, and Cupples soils that have slopes of less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Cupples soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from December through 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. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are western swordfern, deer fern, red huckleberry, western brackenfern, longtube twinflower, and vine maple.

On the basis of a 100-year site curve, the mean site index for western hemlock is 143. On the basis of a 50-

year site curve, it is 102. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 224 cubic feet per acre per year, occurring at age 50. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 154. On the basis of a 50-year site curve, it is estimated to be 118. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 163 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings.

Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**38-Dekapen loam, 8 to 25 percent slopes.** This moderately deep, moderately well drained soil is on mountain plateaus and back slopes. It formed in a mixture of volcanic ash and loess over glacial till derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 1,600 to 2,200 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and the average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 8 inches, the surface layer is dark brown loam. The subsoil is yellowish brown and dark yellowish brown loam 16 inches thick. The next 7 inches is olive brown loam. Dense glacial till that crushes to loam is at a depth of 31 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is gravelly loam, gravelly silt loam, or silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to dense glacial till, or has a less developed subsoil.

Included in this unit are small areas of Revel, Welcome, Rinker, and Oakes soils, soils that are less than 20 inches deep to dense glacial till, and Dekapen soils that have slopes of more than 25 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Dekapen soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from December through 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. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are western swordfern, red huckleberry, western brackenfern, vine maple, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index for western hemlock is 149. On the basis of a 50-year site curve, it is 106. The highest average growth

rate in unmanaged, even-aged stands of western hemlock is 236 cubic feet per acre per year, occurring at age 50. On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 137. On the basis of a 50-year site curve, it is estimated to be 107. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 140 cubic feet per acre per year, occurring at age 70. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the muddiness caused by seasonal wetness and occasional snowpack. During an average year, the snowpack limits the use of equipment and restricts access from January through March. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass IVe.

**39-Deming gravelly silt loam, 5 to 30 percent slopes.**

This very deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash, slope alluvium, and colluvium over unconsolidated glacial till derived from sandstone, conglomerate, metasedimentary rocks, and volcanic rocks. The native vegetation is mainly conifers and shrubs. Elevation is

3,500 to 4,800 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 40 degrees F, and the average frost-free period is about 90 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 upper 3 inches of the subsoil is organic stained, reddish brown gravelly silt loam. The lower 20 inches is dark brown and dark yellowish brown very gravelly loam. The substratum to a depth of 60 inches is dark yellowish brown very gravelly loam. In some areas the surface layer is gravelly loam, gravelly fine sandy loam, or silt loam. In other areas the soil has dense glacial till or bedrock at a depth of 40 to 60 inches, has 35 to 60 percent weathered rock fragments in the subsoil, has less than 6 percent organic carbon in the upper part of the subsoil, does not have a surface layer, or has a less developed subsoil.

Included in this unit are small areas of Potchub, Saar, Shuksan, and Kulshan soils, Rock outcrop, poorly drained soils in depressions, soils that have serpentinitic mineralogy, and Deming soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Deming soil. Available water capacity is high. The effective rooting depth is 60 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. Among the trees of limited extent is mountain hemlock. The common understory plants are red huckleberry, blueleaved huckleberry, salmonberry, deer fern, western brackenfern, and bunchberry dogwood.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 93. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 110 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from November through May. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft

when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, and Pacific silver fir occurs periodically.

This map unit is in capability subclass VIe.

**40-Deming gravelly silt loam, 30 to 60 percent slopes.** This very deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash, slope alluvium, and colluvium over unconsolidated glacial till derived from sandstone, conglomerate, metasedimentary rocks, and volcanic rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 4,800 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 40 degrees F, and the average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface layer is dark brown gravelly silt loam 3 inches thick. The upper 5 inches of the subsoil is organic stained, dark reddish brown gravelly silt loam. The next 7 inches is strong brown very gravelly loam. The lower 22 inches is dark brown very gravelly sandy loam and dark yellowish brown extremely gravelly sandy loam. The substratum to a depth of 60 inches is dark yellowish brown extremely gravelly loamy sand. In some areas the surface layer is gravelly loam, gravelly fine sandy loam, or silt loam. In other areas the soil has dense glacial till or bedrock at a depth of 40 to 60 inches, has 35 to 60 percent weathered rock fragments in the subsoil, has less than 6 percent organic carbon in the upper part of the subsoil, does not have a surface layer, or has a less developed subsoil.

Included in this unit are small areas of Potchub,

Saar, Shuksan, and Kulshan soils, Rock outcrop, poorly drained soils in depressions, soils that have serpentinitic mineralogy, and Deming soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Deming soil. Available water capacity is high. The effective rooting depth is 60 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. Among the trees of limited extent is mountain hemlock. The common understory plants are red huckleberry, blueleaved huckleberry, salmonberry, deer fern, western brackenfern, and bunchberry dogwood.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 93. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 110 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep

snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, and Pacific silver fir occurs periodically.

This map unit is in capability subclass VIIe.

**41-Diobsud gravelly silt loam, 30 to 60 percent slopes.** This moderately deep, moderately well drained soil is on mountain back slopes and ridges. It formed in a mixture of volcanic ash and colluvium over glacial till derived from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 2,800 to 3,800 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 7 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown gravelly silt loam. The upper 9 inches of the subsoil is dark brown and strong brown gravelly silt loam. The lower 4 inches is brown gravelly silt loam. The substratum is olive gray gravelly loam about 17 inches thick. Dense glacial till that crushes to very gravelly loam is at a depth of 37 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly loam. In other areas the soil has a very gravelly subsoil, has rock fragments of mixed mineralogy, is 40 to 60 inches deep to dense glacial till or bedrock, or has less than 6 percent organic carbon in the upper part of the subsoil.

Included in this unit are small areas of Crinker, Clendenen, and Hinker soils, Rock outcrop, and Diobsud soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Diobsud soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through May. 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. Among the trees of limited extent are Alaska cedar, western redcedar, and mountain hemlock. The common understory plants are bunchberry dogwood, queencup

beadlily, tall blue huckleberry, red huckleberry, longtube twinflower, and deer fern.

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, it is 75. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 151 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are present, natural reforestation of cutover areas by western hemlock, mountain hemlock, and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

**42-Edfro very gravelly silt loam, 8 to 30 percent slopes.** This shallow, moderately well drained soil is on high mountain shoulder slopes and back slopes. It formed in a mixture of volcanic ash, loess, and colluvium over glacial till derived dominantly from dunite. The native vegetation is mainly conifers and shrubs. Elevation is 2,400 to 3,600 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 7 inches thick. When mixed to a depth of 4 inches, the surface layer is dark brown very gravelly silt loam. The upper 6 inches of the subsoil is organic stained, reddish brown very gravelly silt loam. The lower 8 inches is dark brown very gravelly loam. Dense glacial till that crushes to very gravelly loamy sand is at a depth of 18 inches. The depth to dense glacial till ranges from 14 to 20 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has a less developed subsoil or is 20 to 30 inches deep to dense glacial till.

Included in this unit are small areas of Diobsud, Crinker, Jackman, Klawatti, and Hinker soils, soils that are shallow over bedrock or very shallow to dense glacial till, Rock outcrop, and Edfro soils that have a stony surface or have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Edfro soil and very slow in the dense glacial till. Available water capacity is low. The 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 from December through April.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, Alaska cedar, and mountain hemlock. The common understory plants are tall blue huckleberry, bunchberry dogwood, western brackenfern, deer fern, and longtube twinflower. Vegetation is somewhat stunted and sparse because of the toxicity of the dunite-derived soil.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, the snowpack limits the use of equipment and restricts access from November through May. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting the production of timber. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock seedlings, which are adapted to the toxicity of dunite soils. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, Pacific silver fir, and Alaska cedar occurs periodically. Trees grow poorly and lack vigor on soils that are derived from dunite. Planting seedlings in the organic layer improves growth and vigor. Because the rooting depth is restricted by the dense glacial till, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

**43-Edfro very gravelly silt loam, 30 to 60 percent slopes.** This shallow, moderately well drained soil is on high mountain shoulder slopes and back slopes. It formed in a mixture of volcanic ash, loess, and colluvium over glacial till derived dominantly from dunite. The native vegetation is mainly conifers and shrubs. Elevation is 2,400 to 3,600 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. When mixed to a depth of 3 inches, the surface layer is brown very gravelly silt loam. The upper 4 inches of the subsoil is

organic stained, strong brown very gravelly silt loam. The lower 12 inches is organic stained, yellowish red and dark brown very gravelly silt loam. Dense glacial till that crushes to very gravelly loam is at a depth of 19 inches. The depth to dense glacial till ranges from 14 to 20 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has a less developed subsoil or is 20 to 30 inches deep to dense glacial till.

Included in this unit are small areas of Diobsud, Crinker, Jackman, Klawatti, and Hinker soils, soils that are shallow over bedrock or very shallow to dense glacial till, Rock outcrop, and Edfro soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Edfro soil and very slow in the dense glacial till. Available water capacity is low. The 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 from December through April.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, Alaska cedar, and mountain hemlock. The common understory plants are tall blue huckleberry, bunchberry dogwood, western brackenfern, deer fern, and longtube twinflower. Vegetation is somewhat stunted and sparse because of the toxicity of the dunite-derived soil.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock seedlings, which are adapted to the toxicity of dunite soils. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, Alaska cedar, and Pacific silver fir occurs periodically. Trees grow poorly and lack vigor on soils that are derived from dunite. Planting seedlings in the organic layer improves growth and vigor. Because the rooting depth is restricted by the dense glacial till, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**44-Edfro very stony silt loam, 30 to 60 percent slopes.** This shallow, moderately well drained soil is on high mountain shoulder slopes and back slopes. It formed in a mixture of volcanic ash, loess, and colluvium over glacial till derived dominantly from dunite. The native vegetation is mainly conifers and shrubs. Elevation is 2,400 to 3,600 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 10 inches thick. When mixed to a depth of 3 inches, the surface layer is dark brown very stony silt loam. The upper 7 inches of the subsoil is organic stained, yellowish red very gravelly silt loam. The lower 6 inches is light olive brown and olive very

gravelly loam. Dense glacial till that crushes to very gravelly loam is at a depth of 16 inches. The depth to dense glacial till ranges from 14 to 20 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is very gravelly silt loam or very gravelly loam. In other areas the soil has a less developed subsoil or is 20 to 30 inches deep to dense glacial till.

Included in this unit are small areas of Diobsud, Crinker, Jackman, Klawatti, and Hinker soils, soils that are shallow over bedrock or very shallow to dense glacial till, Rock outcrop, and Edfro soils that have slopes of more than 60 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Edfro soil and very slow in the dense glacial till. Available water capacity is low. The 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 from December through April.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, Alaska cedar, and mountain hemlock. The common understory plants are tall blue huckleberry, bunchberry dogwood, western brackenfern, deer fern, and longtube twinflower. Vegetation is somewhat stunted and sparse because of the toxicity of the dunite-derived soil.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. The trees can break if they are felled on stones on the surface, and yarding operations can be hindered by the stones. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump

when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock seedlings, which are adapted to the toxicity of dunite soils. Because of the abundance of surface stones, planting seedlings by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, Pacific silver fir, and Alaska cedar occurs periodically. Trees grow poorly and lack vigor on soils that are derived from dunite. Planting seedlings in the organic layer improves growth and vigor. Because the rooting depth is restricted by the dense glacial till, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VI.

**45-Edmonds-Woodlyn loamy, drained, 0 to 2 percent slopes.** This map unit is on outwash terraces and outwash plains. The native vegetation is mainly trees and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 60 percent Edmonds soil and 25 percent Woodlyn soil. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Tromp, Hale, and Fishtrap soils, ponded areas in depressions, and undrained Edmonds and Woodlyn soils. Included areas make up about 15 percent of the total acreage.

The Edmonds soil is very deep and somewhat poorly drained. It has been artificially drained. It formed in an admixture of loess and volcanic ash over glacial outwash. Typically, the surface layer is dark brown loam 11 inches thick. The subsurface layer is dark grayish brown loam 7 inches thick. The subsoil is dark brown and yellowish red, discontinuously cemented, mottled sand 19 inches thick. The substratum to a depth of 60 inches is sand. It is variegated but is dominantly dark grayish brown. The depth to sand ranges from 14 to 20 inches. In some areas the surface layer is sandy loam. In other areas the soil has loamy glaciomarine or clayey marine deposits at a depth of 40 to 60 inches, has a substratum of sandy loam, or has 15 to 35 percent pebbles in the substratum.

Permeability is moderate in the upper part of the Edmonds soil and very rapid in the substratum. Available water capacity is low. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.0 to 2.5 feet from November through April. Runoff usually is very slow, and there is no hazard of erosion.

The Woodlyn soil is shallow and poorly drained. It has been artificially drained. It formed in an admixture of loess and volcanic ash over glacial outwash. Typically, the surface layer is dark brown loam 9 inches thick. The subsurface layer is dark grayish brown and grayish brown loam 3 inches thick. The upper 5 inches of the subsoil is a dark grayish brown, mottled, indurated hardpan that breaks to loamy sand. The lower 8 inches is a dark brown, mottled, weakly cemented hardpan that breaks to loamy sand. The substratum to a depth of 60 inches is coarse sand. It is variegated but is dominantly brown and olive gray. Depth to the hardpan ranges from 10 to 14 inches. In some areas the surface layer is sandy loam. In other areas the soil has loamy glaciomarine or clayey marine deposits at a depth of 40 to 60 inches, has a substratum of sandy loam, has 15 to 35 percent pebbles in the substratum, or has the hardpan at a depth of 14 to 24 inches.

Permeability is moderate in the upper part of the Woodlyn soil, very slow in the hardpan, and very rapid in the loose sand. Available water capacity is low. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.0 to 2.5 feet from November through April. Runoff is very slow, and there is no hazard of erosion.

This unit is used mainly for hay and pasture or as cropland. The included undrained Edmonds and Woodlyn soils are used as woodland.

The main limitations in the areas used for hay and pasture are the seasonal high water table, the low soil fertility, and the low available water capacity. The dominant method of drainage in the areas used for hay

and pasture is open ditches. In areas where the drainage system is not maintained or in areas that do not have drainage, 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. Grazing when the soils are wet results in compaction of the surface layer and poor tilth.

The main limitations in the areas used as cropland are the seasonal high water table, the low soil fertility, and the low available water capacity. The principal crops grown are corn silage and small grain. Because of the inherent low fertility, this unit requires proportionately more fertilizer than most other soils in the survey area to produce similar yields. The hardpan can be ripped and shattered. Ripping and shattering increase the effective rooting depth and improve internal drainage. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping sequence help to maintain fertility and tilth.

Tile drains and field ditches should be maintained for adequate production on cropland and pasture. Maintaining artificial drainage systems permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. Most crops common to the survey area can be grown if the drainage system is adequate. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. In summer, irrigation is required for maximum production.

Red alder is the main woodland species in the undrained areas of this unit. Among the trees of limited extent are western hemlock, western redcedar, bigleaf maple, paper birch, and black cottonwood. The common understory plants are vine maple, salmonberry, red huckleberry, western swordfern, and salal.

On the basis of a 50-year site curve, the mean site index for red alder is 90. The highest average growth rate in unmanaged, even-aged stands of red alder is 101 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The seasonal high water table limits the use of equipment to dry periods. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soils are moist and a moderate degree of puddling when the soils are wet. Carefully laying out roads and skid trails, properly timing

their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soils are wet and winds are strong.

The main limitation affecting homesite development is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The hardpan is rippable and, therefore, is not a serious limitation for most engineering uses. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitations on sites for septic tank absorption fields are the seasonal high water table, the cemented pan in the Woodlyn soil, and a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to compensate for these limitations.

The Edmonds soil is in capability subclass IIIw. The Woodlyn soil is in capability subclass IVw.

#### **46-Eliza silt loam, drained, 0 to 1 percent slopes.**

This very deep, very poorly drained soil is on flood plains and deltas. It has been artificially drained. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is at or near sea level to 20 feet above sea level. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 185 days.

Typically, the surface layer is very dark grayish brown and dark grayish brown silt loam 11 inches thick. The upper 4 inches of the underlying material also is very dark grayish brown and dark grayish brown silt loam. The next 9 inches is gray and dark gray, mottled fine sandy loam. The lower part to a depth of 60 inches is stratified dark gray, gray, strong brown, and light gray, mottled silt loam and fine sandy loam. In some areas the soil has sand at a depth of 30 to 60 inches or is dominantly silt loam with 10 to 18 percent clay.

Included in this unit are small areas of Mt. Vernon

soils, bodies of water, undrained Eliza soils, and Eliza soils that have slopes of 1 to 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Eliza soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.0 to 2.5 feet from November through April. Runoff is very slow, and there is no hazard of erosion. This soil is subject to frequent, brief periods of flooding from November through April. It is subject to tidal inundation unless protected.

This unit is used mainly for hay and pasture, as cropland, or as a site for homes. The included undrained Eliza soils are used as woodland.

The main limitations in the areas used as cropland are the seasonal high water table, the hazard of flooding, and the influence of salt. This soil is well suited to most crops commonly grown in the survey area if adequate drainage systems are maintained. The principal crops are peas, sweet corn, beans, small grain, and corn silage. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Installing tile drains no deeper than 30 inches minimizes the effects of the salt. Tile drains and field ditches should be maintained. They permit fieldwork to be conducted earlier in the spring and increase the yields of perennial crops. Using regulating structures in open ditches as a means of subirrigation can reduce the high acidity in the lower part of the underlying material. In summer, irrigation is required for maximum production.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, black cottonwood, and Sitka spruce. The common understory plants are willow, Douglas spirea, western swordfern, western brackenfern, devilsclub, and Indian plum.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the hazard of flooding and the muddiness caused by seasonal wetness. These limit the use of equipment to dry periods. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and

using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The high water table hinders root respiration and thus results in a low seedling survival rate. The seedling survival rate also may be low where flooding occurs. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitations are the seasonal high water table and the hazard of flooding. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the seasonal high water table and the hazard of flooding. Installing absorption lines that are longer than normal and installing flood-control structures help to overcome these limitations.

This map unit is in capability subclass IIIw.

#### **47-Eliza-Tacoma silt loams, 0 to 1 percent slopes.**

This map unit is on flood plains, deltas, and tidal flats. The native vegetation is mainly trees and shrubs. Elevation is sea level to 20 feet above sea level. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 185 days.

This unit is 45 percent Eliza soil and 35 percent Tacoma soil. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Shalcar, Snohomish, and Mr. Vernon soils and small bodies of water. Included areas make up about 20 percent of the total acreage.

The Eliza soil is very deep and very poorly drained. It formed in alluvium. Typically, the surface layer is dark grayish brown, mottled silt loam 4 inches thick. The upper 8 inches of the underlying material is olive gray, mottled silt loam. The next 12 inches is dark gray, mottled silt loam. The lower part to a depth of 60 inches is dark gray, mottled, stratified sandy loam and loamy sand. Depth to the acid substratum ranges from 30 to

60 inches. In some areas the soil has sand at a depth of 30 to 60 inches.

Permeability is moderate in the Eliza soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface from November through April. Runoff is very slow, and there is no hazard of erosion. This soil is subject to frequent, long periods of flooding from December through April.

The Tacoma soil is very deep and very poorly drained. It formed in alluvium. Typically, the surface layer is dark grayish brown, mottled silt loam 11 inches thick. The upper 7 inches of the underlying material is dark grayish brown, mottled silt loam. The next 30 inches is dark gray, mottled silt loam. The lower part to a depth of 60 inches is dark gray, mottled fine sandy loam. In some areas the surface layer is very fine sandy loam. In other areas the soil has 18 to 35 percent clay in the upper part of the underlying material or is 30 to 40 inches deep to fine sandy loam or sand.

Permeability is moderately slow in the Tacoma soil. Available water capacity is high. The effective rooting depth is limited by a high water table, which is at or near the surface from November through April during periods of high tide. Runoff is very slow, but the hazard of water erosion is severe because of the hazards of flooding and channeling. This soil is subject to frequent, long periods of flooding from December through April. It is subject to tidal inundation unless protected. Channeling and deposition are common along streambanks.

This unit is used as woodland or for wildlife habitat. Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, black cottonwood, and Sitka spruce. The common understory plants are willow, Douglas spirea, western swordfern, western brackenfern, devilsclub, and Indian plum.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the hazard of flooding and the muddiness caused by seasonal wetness. These limit the use of equipment to dry periods. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soils are moist and a high degree of puddling when the soils are wet.

Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The high water table hinders root respiration and thus results in a low seedling survival rate. The seedling survival rate also may be low where flooding occurs. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soils are wet and winds are strong.

The Eliza and Tacoma soils are in capability subclass VIw.

**48-Everett gravelly sandy loam, hard substratum, 2 to 8 percent slopes.** This deep, somewhat excessively drained soil is on outwash terraces and moraines. It formed in a mixture of volcanic ash and alluvium over glacial outwash and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 180 days.

Typically, the surface is covered with a mat of undecomposed needles and twigs 2 inches thick. When mixed to a depth of 6 inches, the surface layer is dark yellowish brown gravelly sandy loam. The upper 7 inches of the subsoil is dark brown gravelly sandy loam. The lower 12 inches is strong brown very gravelly sandy loam. The substratum is dark brown very gravelly loamy sand 16 inches thick. Dense glacial till that crushes to very gravelly loamy sand is at a depth of 41 inches. The depth to very gravelly loamy sand ranges from 14 to 30 inches. The depth to dense glacial till or dense glaciomarine deposits ranges from 40 to 60 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is very gravelly sandy loam or very gravelly loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is very gravelly sandy loam in the upper part of the substratum, or has dense glacial till or dense glaciomarine deposits below a depth of 60 inches.

Included in this unit are small areas of Birchbay, Clipper, Labounty, Sehome, and Squalicum soils and small areas of Everett soils that have a stony surface or

have slopes of more than 8 percent or less than 2 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Everett soil, rapid and very rapid in the substratum, and very slow in the dense glacial till. Available water capacity is low. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 3.5 to 5.0 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used as a site for homes.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and grand fir. The common understory plants are salal, creambush oceanspray, red huckleberry, western swordfern, western brackenfern, common snowberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 138. On the basis of a 50-year site curve, it is 106. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 142 cubic feet per acre per year, occurring at age 70.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation affecting homesite development is the seasonal high water table. The wetness can be reduced by building the house on a pad and by

installing drainage tile around footings if a suitable outlet is available. The dense glacial till is rippable and, therefore, is not a serious limitation for most engineering uses. In shallow excavations special retainer walls may be needed to keep cutbanks from caving.

The main limitations on sites for septic tank absorption fields are a poor filtering capacity in the substratum and the seasonal high water table. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope. Installing the absorption field in the loamy subsoil or in fill approved by the health district helps to compensate for these limitations.

This map unit is in capability subclass IIIe.

**49-Everett very gravelly sandy loam, 8 to 15 percent slopes.** This very deep, somewhat excessively drained soil is on outwash terraces and moraines. It formed in a mixture of volcanic ash and alluvium over glacial outwash and glacial till. The native vegetation is mainly conifer and shrubs. Elevation is 100 to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 180 days.

Typically, the surface is covered with a mat of undecomposed needles, twigs, and rotting wood 4 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown very gravelly sandy loam. The subsoil is dark brown very gravelly sandy loam 12 inches thick. The substratum to a depth of 60 inches is variegated very gravelly sand. The depth to very gravelly sand ranges from 14 to 24 inches. In some areas the surface layer is very gravelly loam, gravelly sandy loam, or gravelly loam. In other areas the soil has a substratum of very gravelly sand at a depth of 24 to 36 inches, has a weakly cemented hardpan at a depth of 40 to 60 inches, has 15 to 35 percent rock fragments in the subsoil, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Birchbay, Clipper, and Squalicum soils and small areas of Everett soils that have a stony surface or have slopes of more than 15 percent or less than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is rapid in the upper part of the Everett soil and very rapid in the lower part. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture, as a source of aggregate, and as a site for homes.

Douglas fir is the main woodland species. Among the

trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common understory plants are salal, western brackenfern, red huckleberry, rose, Oregongrape, and creambush oceanspray.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 138. On the basis of a 50-year site curve, it is 106. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 142 cubic feet per acre per year, occurring at age 70.

The kind of equipment that can be used and the time of the year when it can be used normally are not restricted on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitations in the areas used for hay and pasture are the low available water capacity and the slope.

If this unit is used for homesite development, the main limitation is the slope. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Installing the absorption field in the loamy subsoil or in fill approved by the health district helps to compensate for this limitation. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope. The slope affects the installation of septic tank absorption fields. The absorption lines should be installed on the contour.

This map unit is in capability subclass IVe.

#### **50-Everett very gravelly sandy loam, 15 to 35**

**percent slopes.** This very deep, somewhat excessively drained soil is on outwash terraces and moraines. It formed in a mixture of volcanic ash and alluvium over glacial outwash and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 180 days.

Typically, the surface is covered with a mat of undecomposed needles, twigs, and rotting wood 4 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown very gravelly sandy loam. The subsoil is dark brown very gravelly sandy loam 12 inches thick. The substratum to a depth of 60 inches is variegated very gravelly sand. The depth to very gravelly sand ranges from 14 to 24 inches. In some areas the surface layer is very gravelly loam, gravelly sandy loam, or gravelly loam. In other areas the soil has a substratum of very gravelly sand at a depth of 24 to 36 inches, has a weakly cemented hardpan at a depth of 40 to 60 inches, has 15 to 35 percent rock fragments in the subsoil, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Birchbay, Clipper, and Squalicum soils and small areas of Everett soils that have a stony surface or have slopes of more than 35 percent or less than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is rapid in the upper part of the Everett soil and very rapid in the lower part. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture and as a source of aggregate.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common understory plants are salal, western brackenfern, red huckleberry, Oregongrape, and western swordfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 138. On the basis of a 50-year site curve, it is 106. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 142 cubic feet per acre per year, occurring at age 70.

The kind of equipment that can be used and the time of the year when it can be used normally are not restricted on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round

use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitations in the areas used for hay and pasture are the low available water capacity, the hazard of erosion, and the slope.

The main limitation affecting homesite development is the slope. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitations on sites for septic tank absorption fields are the slope and a poor filtering capacity in the substratum. Installing the absorption field in the loamy subsoil or in fill approved by the health district helps to compensate for these limitations. The slope affects the installation of septic tank absorption fields. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope.

This map unit is in capability subclass IVe.

**51-Everett complex, 2 to 8 percent slopes.** This map unit is on outwash terraces and moraines. It formed in a mixture of volcanic ash and alluvium over glacial outwash and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 500 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 180 days.

This unit is 50 percent Everett very gravelly sandy loam and 35 percent Everett gravelly sandy loam. The components of this unit occur as areas so intricately

intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Birchbay, Clipper, Labounty, and Squalicum soils and small areas of Everett soils that have a stony surface, have a surface layer of very gravelly sand, or have slopes of more than 8 percent or less than 2 percent. Also included are soils that are similar to the Everett soil but have 15 to 35 percent rock fragments in the subsoil or have a substratum of very gravelly sandy loam. Included areas make up about 15 percent of the total acreage.

Everett very gravelly sandy loam is very deep and somewhat excessively drained. Typically, the surface is covered with a mat of undecomposed needles, twigs, and rotting wood 4 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown very gravelly sandy loam. The subsoil is dark brown very gravelly sandy loam 12 inches thick. The substratum to a depth of 60 inches is variegated very gravelly sand. The depth to very gravelly sand ranges from 14 to 24 inches.

Permeability is rapid in the upper part of this Everett soil and very rapid in the lower part. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

Everett gravelly sandy loam is deep and well drained. Typically, the surface is covered with a mat of undecomposed needles and twigs 2 inches thick. When mixed to a depth of 6 inches, the surface layer is dark yellowish brown gravelly sandy loam. The upper 7 inches of the subsoil is dark brown gravelly sandy loam. The lower 12 inches is strong brown very gravelly sandy loam. The substratum is dark brown very gravelly loamy sand 16 inches thick. Dense glacial till that crushes to very gravelly loamy sand is at a depth of 41 inches. The depth to very gravelly loamy sand ranges from 14 to 30 inches. The depth to dense glacial till or dense glaciomarine deposits ranges from 40 to 60 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is very gravelly sandy loam or very gravelly loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is very gravelly sandy loam in the upper part of the substratum, or has weakly cemented glacial till or glaciomarine deposits.

Permeability is moderate in the upper part of this Everett soil, rapid in the next part, and very slow in the dense glacial till. Available water capacity is low. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 3.5 to 5.0 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture, as cropland, as a source of aggregate, and as a site for homes.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, bigleaf maple, and grand fir. The common understory plants are salal, western brackenfern, red huckleberry, Oregongrape, and western swordfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 138. On the basis of a 50-year site curve, it is 106. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 142 cubic feet per acre per year, occurring at age 70.

The kind of equipment that can be used and the time of the year when it can be used normally are not restricted on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation in the areas used for hay and pasture is the low available water capacity.

The main limitations in the areas used as cropland are the low available water capacity and the very gravelly surface layer. The principal crop is corn silage. The pebbles in the surface layer make tillage difficult and can cause equipment damage. In summer, irrigation is required for maximum production.

If this unit is used for homesite development, the main limitation is the seasonal high water table. The dense glacial till is rippable and, therefore, is not a serious limitation for most engineering uses. In shallow excavations special retainer walls may be needed to

keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. The seasonal high water table in Everett gravelly sandy loam also is a limitation. Installing the absorption field in the loamy subsoil or in fill approved by the health district helps to compensate for these limitations. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope.

Everett very gravelly sandy loam is in capability subclass IVe. Everett gravelly sandy loam is in capability subclass IIIe.

**52-Everett-Urban land complex, 5 to 20 percent slopes.** This map unit is on outwash terraces. The native vegetation is mainly conifers and shrubs. 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 period is about 170 days.

This unit is 50 percent Everett gravelly sandy loam and 30 percent Urban land. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Chuckanut, Squalicum, Sehome, Whatcom, and Labounty soils and small areas of Everett soils that have slopes of more than 20 percent or less than 5 percent. Included areas make up about 20 percent of the total acreage.

The Everett soil is deep and well drained. It formed in a mixture of volcanic ash and alluvium over glacial outwash and glacial till. When mixed to a depth of 6 inches, the surface layer is dark yellowish brown gravelly sandy loam. The upper 7 inches of the subsoil is dark brown gravelly sandy loam. The lower 12 inches is strong brown very gravelly sandy loam. The substratum is dark brown very gravelly loamy sand 16 inches thick. Dense glacial till that crushes to very gravelly loamy sand is at a depth of 41 inches. The depth to very gravelly loamy sand ranges from 14 to 30 inches. The depth to dense glacial till ranges from 40 to 60 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is very gravelly sandy loam and the soil has 15 to 35 percent rock fragments in the subsoil. In other areas the soil is very gravelly sandy loam in the upper part of the substratum, has dense glacial till below a depth of 60 inches, or has weakly cemented dense glacial till.

Permeability is moderate in the upper part of the Everett soil, rapid in the next part, and very slow in the dense glacial till. Available water capacity is low. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 3.5 to 5.0 feet from

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

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

The Everett soil is used for lawns, gardens, parks, or vacant lots. It is highly erodible during construction and on cut and fill slopes.

If this unit is used for homesite development, the main limitations are the slope and the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tiles around footings if a suitable outlet is available. The dense glacial till is rippable and, therefore, is not a serious limitation for most engineering uses. In shallow excavations special retainer walls may be needed to keep cutbanks from caving.

The main limitations on sites for septic tank absorption fields are a poor filtering capacity in the substratum and the seasonal high water table. Installing the absorption field in the loamy subsoil or in fill approved by the health district helps to compensate for these limitations. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope. The absorption lines should be installed on the contour.

The Everett soil is in capability subclass IIIe. The Urban land is in capability subclass VIIIc.

### **53-Everson silt loam, drained, 0 to 2 percent slopes.**

This very deep, poorly drained soil is in depressions on outwash terraces. It has been artificially drained. It formed in lacustrine deposits, alluvium, and glacial outwash with an admixture of loess. The native vegetation is mainly trees and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is very dark grayish brown silt loam 7 inches thick. The subsoil is grayish brown, mottled silty clay 12 inches thick. The upper 21 inches of the substratum is dark grayish brown and grayish brown sand. The lower part to a depth of 60 inches is stratified dark grayish brown very gravelly loamy sand and olive brown gravelly sand. The depth to sand ranges from 14 to 30 inches. In some areas the soil has a substratum of sandy loam or gravelly sandy loam or has more than 15 percent rock fragments in the upper part of the substratum.

Included in this unit are small areas of Hale, Whitehorn, Labounty, and Edmonds soils, undrained Everson soils, and soils that are similar to the Everson

soil but have 18 to 35 percent clay in the subsoil or have a hardpan of dense glaciomarine drift at a depth of 40 to 60 inches. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the upper part of the Everson soil and very rapid in the lower part. Available water capacity is moderate. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 3 feet from November through April. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion.

This unit is used mainly for hay and pasture or as cropland. It also is used as a site for homes. The included undrained Everson soils are used as woodland.

The main limitations in the areas used for hay and pasture are the seasonal high water table and the moderate available water capacity. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. The water table limits the use of this unit to grasses and shallow-rooted legumes unless a drainage system is installed. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

The main limitations in the areas used as cropland are the seasonal high water table and the moderate available water capacity. The principal crops are small grain and corn silage. This soil is well suited to most crops commonly grown in the survey area if adequate drainage systems are maintained. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Tile drains and field ditches should be maintained. They permit fieldwork to be conducted earlier in the spring and increase the yields of perennial crops. In summer, irrigation is required for maximum production.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, and bigleaf maple. The common understory plants are willow, Douglas spirea, western swordfern, western brackenfern, devilscub, and Indian plum.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The high water table limits the use of equipment to dry periods. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is

needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitation is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the seasonal high water table and a poor filtering capacity. Installing the absorption field in fill approved by the health district helps to compensate for these limitations.

This map unit is in capability subclass IIIw.

#### **54-Fishtrap muck, drained, 0 to 2 percent slopes.**

This very deep, very poorly drained soil is in depressions on outwash terraces. It has been artificially drained. It formed in herbaceous and woody organic deposits over glaciofluvial deposits. The native vegetation is mainly shrubs, forbs, and trees. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is very dark grayish brown muck 7 inches thick. The upper 12 inches of the underlying material is very dark brown muck. The lower part to a depth of 60 inches is dark grayish brown and dark gray, mottled sand. In some areas the surface layer is mucky silt loam. In other areas the soil has hemic material in the surface layer, is more than 51 inches deep to the lower part of the underlying material, or is loamy in the lower part of the underlying material.

Included in this unit are small areas of Hale and Tromp soils, areas that are ponded, bodies of water,

undrained Fishtrap soils, and Fishtrap soils that have slopes of more than 2 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Fishtrap soil and very rapid in the lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 2.5 feet from October through May. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion.

This unit is used mainly for hay and pasture or as cropland. The included undrained Fishtrap soils are used as woodland.

The main limitation in the areas used for hay and pasture is the seasonal high water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

The main limitations in the areas used as cropland are the seasonal high water table and the soil acidity. This soil is well suited to most crops commonly grown in the survey area if adequate drainage systems are maintained. The principal crops are potatoes, blueberries, and corn silage. Tile drains and field ditches should be maintained. They permit fieldwork to be conducted earlier in the spring and increase the yields of perennial crops. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Subsidence is minimized if the water table is maintained directly below the root zone during the growing season and then allowed to return to the surface during the winter. Using regulating structures in open ditches as a means of subirrigation reduces the extent of subsidence. In summer, irrigation is required for maximum production.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, lodgepole pine, and Sitka spruce. The common understory plants are willow, Douglas spirea, salmonberry, stinging nettle, and sedges.

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 in unmanaged, even-aged stands of red alder is about 92 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The high water table limits the use of equipment to dry periods. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is

needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

The main limitations affecting homesite development are the seasonal high water table and the low strength. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. If buildings are constructed on this soil, the muck should be excavated or the buildings should be constructed on piles anchored in the mineral soil. The design of buildings and roads can offset the limited ability of the soil to support a load. In shallow excavations special retainer walls may be needed to keep cutbanks from caving.

The main limitations on sites for septic tank absorption fields are the seasonal high water table and a poor filtering capacity. Installing the absorption field in fill approved by the health district helps to compensate for these limitations.

This map unit is in capability subclass IIw.

**55-Gallup silt loam, 30 to 60 percent slopes.** This very deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash, loess, colluvium, slope alluvium, and unconsolidated glacial till derived from sandstone and metasedimentary rocks. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and rotting logs 12 inches thick. The surface layer is dark brown silt loam 6 inches thick. The upper 8 inches of the subsoil is organic stained,

dark reddish brown and yellowish red gravelly loam and gravelly silt loam. The lower 15 inches is dark brown and dark yellowish brown gravelly loam. The substratum to a depth of 60 inches is dark yellowish brown gravelly loam. In some areas the surface layer is gravelly silt loam, loam, or gravelly loam. In other areas the soil has dense glacial till or bedrock at a depth of 40 to 60 inches, has a very gravelly subsoil, has less than 6 percent organic carbon in the upper part of the subsoil, or has a less developed subsoil.

Included in this unit are small areas of Potchub, Hartnit, and Saar soils, Rock outcrop, soils that have serpentinitic mineralogy, and Gallup soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Gallup soil. Available water capacity is high. The effective rooting depth is 60 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. The common understory plants are blueleaved huckleberry, bunchberry dogwood, deer fern, western brackenfern, and salmonberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is 118. On the basis of a 50-year site curve, it is 78. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 176 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. These systems generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment

can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and establishment are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, Pacific silver fir, or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

**56-Gallup silt loam, 60 to 80 percent slopes.** This very deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash, loess, colluvium, slope alluvium, and unconsolidated glacial till derived from sandstone and metasedimentary rocks. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and rotting logs 12 inches thick. The surface layer is dark brown silt loam 3 inches thick. The upper 11 inches of the subsoil is organic stained, dark reddish brown and yellowish red gravelly loam and gravelly silt loam. The lower 25 inches is dark brown and dark yellowish brown gravelly loam. The substratum to a depth of 60 inches is dark yellowish brown gravelly loam. In some areas the surface layer is gravelly silt loam, loam, or gravelly loam. In other areas the soil has dense glacial till or bedrock at a depth of 40 to 60 inches, has a very gravelly subsoil, has less than 6 percent organic carbon in the upper part of the subsoil, or has a less developed subsoil.

Included in this unit are small areas of Potchub, Hartnit, and Saar soils, Rock outcrop, soils that have serpentinitic mineralogy, and Gallup soils that have slopes of less than 60 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Gallup soil. Available water capacity is high. The effective rooting depth is 60

inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. The common understory plants are blueleaved huckleberry, bunchberry dogwood, deer fern, western brackenfern, and salmonberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is 118. On the basis of a 50-year site curve, it is 78. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 176 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. These systems generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and establishment are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western

hemlock, Pacific silver fir, or noble fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

#### **57-Gallup silt loam, cold, 30 to 60 percent slopes.**

This very deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash, loess, colluvium, slope alluvium, and unconsolidated glacial till derived from sandstone and metasedimentary rocks. The native vegetation is mainly conifers and shrubs. Elevation is 3,600 to 4,500 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 40 degrees F, and the average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and rotting logs 12 inches thick. When mixed to a depth of 6 inches, the surface layer is very dark gray silt loam. The upper 6 inches of the subsoil is organic stained, strong brown loam. The lower 17 inches is dark brown and yellowish brown loam. The substratum to a depth of 60 inches is dark grayish brown gravelly loam. In some areas the surface layer is gravelly silt loam, loam, or gravelly loam. In other areas the soil has dense glacial till or bedrock at a depth of 40 to 60 inches, has a very gravelly subsoil, has less than 6 percent organic carbon in the upper part of the subsoil, or has a less developed subsoil.

Included in this unit are small areas of Potchub, Kulshan, and Shuksan soils, Rock outcrop, soils that have serpentinitic mineralogy, and Gallup soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Gallup soil. Available water capacity is high. The effective rooting depth is 60 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. Among the trees of limited extent is mountain hemlock. The common understory plants are red huckleberry, blueleaved huckleberry, bunchberry dogwood, trailing blackberry, deer fern, western brackenfern, and salmonberry:

On the basis of a 100-year site curve, the mean site index for western hemlock is 93. On the basis of a 50-year site curve, it is 65. The highest average growth rate in unmanaged, even-aged stands of western

hemlock is 110 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of: the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Carefully laying out yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground also reduce the degree of compaction. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, and Pacific silver fir occurs periodically.

This map unit is in capability subclass VIIe.

#### **58-Gallup silt loam, cold, 60 to 80 percent slopes.**

This very deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash, loess, colluvium, slope alluvium, and unconsolidated glacial till derived from sandstone and metasedimentary rocks.

The native vegetation is mainly conifers and shrubs. Elevation is 3,600 to 4,500 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 40 degrees F, and the average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and rotting logs 12 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown silt loam. The upper 21 inches of the subsoil is organic stained, dark reddish brown and yellowish red gravelly loam. The lower 12 inches is dark brown and dark yellowish brown gravelly loam. The substratum to a depth of 60 inches is dark yellowish brown gravelly loam. In some areas the surface layer is gravelly silt loam, loam, or gravelly loam. In other areas the soil has dense glacial till or bedrock at a depth of 40 to 60 inches, has a very gravelly subsoil, has less than 6 percent organic carbon in the upper part of the subsoil, or has a less developed subsoil.

Included in this unit are small areas of Potchub, Kulshan, and Shuksan soils, Rock outcrop, soils that have serpentinitic mineralogy, and Gallop soils that have slopes of less than 60 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Gallop soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is mountain hemlock. The common understory plants are red huckleberry, blueleaved huckleberry, bunchberry dogwood, trailing blackberry, deer fern, western brackenfern, and salmonberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is 93. On the basis of a 50-year site curve, it is 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 110 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. These systems generally are used on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer

during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. Because of the slope, planting seedlings is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, and Pacific silver fir occurs periodically.

This map unit is in capability subclass VIIe.

**59-Getchell loam, 3 to 30 percent slopes.** This moderately deep, moderately well drained soil is on high mountain back slopes and plateaus. It formed in an admixture of volcanic ash and colluvium over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 105 days.

Typically, the surface is covered with a mat of needles and twigs 5 inches thick. When mixed to a depth of 4 inches, the surface layer is dark brown loam. The upper 8 inches of the subsoil is dark brown sandy loam. The lower 24 inches is brown sandy loam. Dense glacial till that crushes to sandy loam is at a depth of 36 inches. The depth to dense glacial till ranges from 200 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is silt loam or gravelly loam. In other areas the soil has a gravelly subsoil, has 15 to 35 percent phyllite rock fragments in

the subsoil and in the dense glacial till, is 40 to 60 inches deep to dense glacial till or sandstone, has more than 6 percent organic carbon in the lower part of the surface layer and upper part of the subsoil, or has a less developed subsoil.

Included in this unit are small areas of Hartnit, Kindy, Oso, and Revel soils, soils that are less than 20 inches deep to dense glacial till, Rock outcrop, poorly drained soils in depressions, and Getchell soils that have slopes of more than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Getchell soil and very slow in the dense glacial till. Available water capacity is high. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, Douglas fir, and western redcedar. The common understory plants are red huckleberry, deer fern, western brackenfern, devilsclub, ladyfern, and bunchberry dogwood.

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, it is 91. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 198 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from December through April. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep

snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

**60-Getchell loam, 30 to 60 percent slopes.** This moderately deep, moderately well drained soil is on high mountain back slopes and plateaus. It formed in an admixture of volcanic ash and colluvium over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 3,000 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 105 days.

Typically, the surface is covered with a mat of needles and twigs 4 inches thick. The surface layer is dark reddish brown loam 2 inches thick. The upper 10 inches of the subsoil is dark yellowish brown loam. The lower 22 inches is dark yellowish brown gravelly loam. Dense glacial till that crushes to gravelly loam is at a depth of 34 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is silt loam or gravelly loam. In other areas the soil has a nongravelly subsoil, has 15 to 35 percent phyllite rock fragments in the subsoil and in the dense glacial till, is 40 to 60 inches deep to dense glacial till or sandstone, has more than 6 percent organic carbon in the upper part of the subsoil, or has a less developed subsoil.

Included in this unit are small areas of Hartnit, Kindy, Oso, and Revel soils, soils that are less than 20 inches deep to dense glacial till, Rock outcrop, poorly drained soils in depressions, and Getchell soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Getchell soil and very slow in the dense glacial till. Available water capacity is high. The effective rooting depth is 20 to 40 inches. Water is perched above the

dense glacial till from November through April. Runoff is medium, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, Douglas fir, and western redcedar. The common understory plants are red huckleberry, deer fern, western brackenfern, devilsclub, ladyfern, and bunchberry dogwood.

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, it is 91. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 198 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from December through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and

Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**61-Hale silt loam, 0 to 2 percent slopes.** This very deep, somewhat poorly drained soil is on outwash terraces. It formed in an admixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly trees and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, when mixed to a depth of 8 inches, the surface layer is dark brown silt loam. The subsoil is light olive brown, mottled loam 8 inches thick. The substratum to a depth of 60 inches is mottled sand. It is variegated but is dominantly grayish brown. The depth to sand or loamy sand ranges from 15 to 30 inches. In some areas the surface layer is loam. In other areas the soil has a substratum of sandy loam, gravelly sandy loam, gravelly sand, or very gravelly sand.

Included in this unit are small areas of Whitehorn, Everson, Edmonds, Labounty, Shalcar, Fishtrap, and Yelm soils, drained Hale soils, and soils that are similar to the Hale soil but have 18 to 35 percent clay in the subsoil or have a hardpan of dense glaciomarine drift at a depth of 40 to 60 inches. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the upper part of the Hale soil and very rapid in the substratum. Available water capacity is moderate. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 2 feet from November through April. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion.

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

Red alder and Douglas fir are the main woodland species. Among the trees of limited extent are western hemlock and western redcedar. The common understory plants are salmonberry, western brackenfern, red huckleberry, western swordfern, trailing blackberry, and sweetscented bedstraw.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year,

occurring at age 40. 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, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 115 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder, Douglas fir, or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitation in the areas used for hay and pasture is the seasonal high water table. The water table limits the use of this unit to grasses unless a drainage system is installed. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

This map unit is in capability subclass IVw.

#### **62-Hale silt loam, drained, 0 to 2 percent slopes.**

This very deep, somewhat poorly drained soil is on outwash terraces. It has been artificially drained. It formed in an admixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly trees and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is very dark grayish brown silt loam 10 inches thick. The subsoil is about 16

inches of mottled olive gray, grayish brown, dark brown, and strong brown silt loam and loam. The upper 12 inches of the substratum is dark grayish brown loamy fine sand. The lower part to a depth of 60 inches is sand. It is variegated but is dominantly dark grayish brown. The depth to sand or loamy sand ranges from 15 to 30 inches. In some areas the surface layer is loam. In other areas the soil has a substratum of sandy loam, gravelly sandy loam, gravelly sand, or very gravelly sand.

Included in this unit are small areas of Birchbay, Lynden, Kickerville, Whitehorn, Everson, Labounty, Fishtrap, Edmonds, and Laxton soils, undrained Hale soils, and soils that are similar to the Hale soil but have 18 to 35 percent clay in the subsoil or have a hardpan of dense glaciomarine drift at a depth of 40 to 60 inches. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the upper part of the Hale soil and very rapid in the substratum. Available water capacity is moderate. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 4 feet from November through April. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion.

This unit is used mainly for hay and pasture or as cropland. It also is used as woodland and as a site for homes.

The main limitations in the areas used for hay and pasture are the seasonal high water table and the moderate available water capacity. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. The water table limits the use of this unit to grasses unless a drainage system is installed. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

The main limitations in the areas used as cropland are the seasonal high water table and the moderate available water capacity. The principal crops are small grain and corn silage. This unit is well suited to most crops commonly grown in the survey area if adequate drainage systems are maintained. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Tile drains and field ditches should be maintained. They permit fieldwork to be conducted earlier in the spring and increase the yields of perennial crops. In summer, irrigation is required for maximum production.

Red alder and Douglas fir are the main woodland species. Among the trees of limited extent are western hemlock and western redcedar. The common

understory plants are salmonberry, western brackenfern, red huckleberry, western swordfern, trailing blackberry, and sweetscented bedstraw.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40. 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, it is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 115 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder, Douglas fir, or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitation affecting homesite development is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitations on sites for septic tank absorption fields are the seasonal high water table and a poor filtering capacity in the substratum. Installing absorption lines that are longer than normal helps to overcome these limitations.

This map unit is in capability subclass IIw.

**63-Hallenton silt loam, 0 to 1 percent slopes.** This very deep, very poorly drained soil is in depressions on glaciomarine drift plains. It formed in a mixture of loess, volcanic ash, and glaciomarine drift. The native vegetation is mainly forbs, shrubs, and trees. Elevation is 200 to 300 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is grayish brown silt loam 11 inches thick. The subsoil is light brownish gray, mottled silt loam 8 inches thick. The substratum to a depth of 60 inches is olive, mottled silt loam. In some areas the surface layer is loam. In other areas the substratum has 10 to 18 percent clay, has lenses of sandy material, or has 0 to 10 percent cobbles.

Included in this unit are small areas of Whatcom, Labounty, and Shalcar soils and bodies of water. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the Hallenton soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface from November through August. Runoff is very slow, and there is no hazard of erosion.

This unit is used for wildlife habitat. Common plants are Douglas spirea, cattail, skunkcabbage, and salmonberry.

This map unit is in capability subclass VIIw.

**64-Hannegan very gravelly loam, 15 to 40 percent slopes.** This shallow, well drained soil is on mountain shoulder slopes and ridges. It formed in a mixture of volcanic ash, loess, and colluvium derived dominantly from phyllite and sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 3,800 to 4,200 feet. The average annual precipitation is about 100 inches, the average annual air temperature is about 40 degrees F, and the average frost-free period is about 90 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 5 inches thick. When mixed to a depth of 5 inches, the surface layer is dark brown very gravelly loam. The subsoil is dark yellowish brown very cobbly loam 12 inches thick. Phyllite is at a depth of about 17 inches. The depth to phyllite ranges from 14 to 20 inches. In some areas the surface layer is very cobbly loam or very gravelly silt loam. In other areas the soil has less than 35 percent hard pebbles in the subsoil or is 20 to 30 inches deep to phyllite.

Included in this unit are small areas of Clendenen and Saar soils, Rock outcrop, and Hannegan soils that have slopes of more than 40 percent or less than 15 percent. Included areas make up about 20 percent of

the total acreage. The percentage varies from one area to another.

Permeability is moderate in the Hannegan soil. Available water capacity is low. The effective rooting depth is 14 to 20 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. Among the trees of limited extent is mountain hemlock. The common understory plants are tall blue huckleberry, salmonberry, bunchberry dogwood, deer fern, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, the snowpack limits the use of equipment and restricts access from November through May. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Phyllite, a poor-quality rock for road construction, is readily available. Extra rock is needed to maintain a stable, uniform road surface. Cut and fill slopes tend to slump when wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

#### **65-Hartnit silt loam, cold, 5 to 30 percent slopes.**

This moderately deep, well drained soil is on mountain back slopes and plateaus. It formed in a mixture of volcanic ash, glacial till, and colluvium derived from sandstone and metasedimentary rocks. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles and twigs 4 inches thick. When mixed to a depth of 4 inches, the surface layer is dark brown silt loam. The upper 15 inches of the subsoil is gravelly silt loam. The lower 6 inches is dark yellowish brown very gravelly loam. Bedrock is at a depth of about 25 inches. The depth to bedrock ranges from 20 to 40 inches. In some areas the surface layer is loam, gravelly loam, or gravelly silt loam. In other areas the soil is very gravelly in the upper part of the subsoil, is 40 to 60 inches deep over bedrock, or is more developed in the upper part of the subsoil.

Included in this unit are small areas of Klawatti, Getchell, Kindy, and Gallup soils, Rock outcrop, poorly drained mineral and organic soils in depressions, soils that are less than 20 inches deep over bedrock, and Hartnit soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Hartnit soil. Available water capacity is moderate. The 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. Among the trees of limited extent are Pacific silver fir, western redcedar, Douglas fir, and mountain hemlock. The common understory plants are red huckleberry, blueleaved huckleberry, bunchberry dogwood, and longtube twinflower.

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, it is estimated to be 75. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 151 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from November through April. The use of wheeled and

tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

#### **66-Hartnit silt loam, cold, 30 to 60 percent slopes.**

This moderately deep, well drained soil is on mountain back slopes and plateaus. It formed in a mixture of volcanic ash, loess, glacial till, and colluvium derived from sandstone and metasedimentary rocks. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles and twigs 4 inches thick. When mixed to a depth of 4 inches, the surface layer is dark brown silt loam. The upper 15 inches of the subsoil is dark brown and brown gravelly loam and gravelly silt loam. The

lower 6 inches is dark yellowish brown very gravelly loam. Bedrock is at a depth of about 25 inches. The depth to bedrock ranges from 20 to 40 inches. In some areas the surface layer is loam, gravelly loam, or gravelly silt loam. In other areas the soil is very gravelly in the upper part of the subsoil, is 40 to 60 inches deep over bedrock, or is more developed in the upper part of the subsoil.

Included in this unit are small areas of Klawatti, Getchell, Kindy, and Gallup soils, Rock outcrop, poorly drained mineral and organic soils in depressions, soils that are less than 20 inches deep over bedrock, and Hartnit soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Hartnit soil. Available water capacity also is moderate. The 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 (fig. 4). Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, western redcedar, and Douglas fir. The common understory plants are red huckleberry, blueleaved huckleberry, bunchberry dogwood, and longtube twinflower.

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, it is estimated to be 75. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 151 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off



Figure 4.-A clear-cut area of Hartnit silt loam, cold, 30 to 60 percent slopes, in the foreground.

the ground can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural

reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**67-Hartnit-Gallup-Rock outcrop complex, 50 to 80 percent slopes.** This map unit is on mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average

annual precipitation is about 90 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 95 days.

This unit is 40 percent Hartnit silt loam, 30 percent Gallup silt loam, and 15 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Saar soils, soils that are less than 20 inches deep over bedrock, stony areas, and Hartnit and Gallup soils that have slopes of more than 80 percent or less than 50 percent. Included areas make up about 15 percent of the total acreage.

The Hartnit soil is moderately deep and well drained. It formed in a mixture of volcanic ash, colluvium, and glacial till derived from sandstone and metasedimentary rocks. Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. When mixed to a depth of 8 inches, the surface layer is dark brown and strong brown silt loam. The upper 11 inches of the subsoil is dark yellowish brown gravelly silt loam. The lower 12 inches is yellowish brown gravelly silt loam. Sandstone is at a depth of about 31 inches. The depth to bedrock ranges from 20 to 40 inches. In some areas the soil has a surface layer of loam or gravelly silt loam, has bedrock at a depth of 40 to 60 inches, has less than 6 percent organic carbon in the upper part of the subsoil, or has a less developed subsoil.

Permeability is moderate in the Hartnit soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

The Gallup soil is very deep and well drained. It formed in a mixture of volcanic ash, loess, colluvium, slope alluvium, and unconsolidated glacial till derived from sandstone and metasedimentary rocks. Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. When mixed to a depth of 8 inches, the surface layer is dark brown and strong brown silt loam. The subsoil is yellowish brown gravelly silt loam 16 inches thick. The substratum to a depth of 60 inches is light olive brown gravelly silt loam. In some areas the surface layer is gravelly silt loam, loam, or gravelly loam. In other areas the soil has dense glacial till or bedrock at a depth of 40 to 60 inches, has a very gravelly subsoil, has less than 6 percent organic carbon in the upper part of the subsoil or lower part of the surface layer, or has a less developed subsoil.

Permeability is moderate in the Gallup soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is sandstone. It is hard

and generally unweathered. 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. Among the trees of limited extent are western redcedar and Douglas fir. The common understory plants are red huckleberry, blueleaved huckleberry, bunchberry dogwood, trailing blackberry, and deer fern.

On the basis of a 100-year site curve, the mean site index for western hemlock on the Hartnit soil is estimated to be 105. On the basis of a 50-year site curve, it is estimated to be 75. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 151 cubic feet per acre per year, occurring at age 60. On the basis of a 100-year site curve, the mean site index for western hemlock on the Gallup soil is estimated to be 118. On the basis of a 50-year site curve, it is estimated to be 78. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 176 cubic feet per acre per year, occurring at age 50. Yields are reduced by the extent of the Rock outcrop. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the Rock outcrop, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. The pattern of the Rock outcrop on the landscape results in a discontinuous slope, which hinders the use of cable yarding systems. These systems generally are used on this unit. The trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soils are moist and a high degree of puddling when the soils are wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling

and gulying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, noble fir, or Pacific silver fir seedlings. The slope makes the planting of seedlings difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees on the Hartnit soil are occasionally subject to windthrow when the soils are wet and winds are strong.

The Hartnit and Gallup soils are in capability subclass VIle. The Rock outcrop is in capability subclass VIIIs.

**68-Heisler very gravelly silt loam, 8 to 30 percent slopes.** This very deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash and loess over colluvium derived from glacial till high in content of phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 400 to 1,200 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles and twigs 4 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown very gravelly silt loam. The upper 18 inches of the subsoil is yellowish brown very gravelly silt loam. The lower 8 inches is light olive brown extremely channery loam. The substratum to a depth of 60 inches is pale olive extremely channery sandy loam. In some areas the surface layer is very gravelly loam, gravelly loam, or gravelly silt loam. In other areas the soil has less than 35 percent rock fragments in the subsoil and substratum or is not dominated by phyllite.

Included in this unit are small areas of Vanzandt, Squires, and Barneston soils and small areas of Heisler soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Heisler soil. Available

water capacity also is moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common understory plants are western swordfern, Oregongrape, red huckleberry, deer fern, Pacific trillium, bedstraw, and salal.

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, it is 127. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 176 cubic feet per acre per year, occurring at age 60.

The kind of equipment that can be used and the time of the year when it can be used normally are not restricted on this unit. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Steep skid trails and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVe.

**69-Heisler very gravelly silt loam, 30 to 60 percent slopes.** This very deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash and loess over colluvium derived from glacial till high in content of phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 400 to 1,200 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles and twigs 4 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown very

gravelly silt loam. The upper 18 inches of the subsoil is yellowish brown very gravelly silt loam. The lower 8 inches is light olive brown extremely channery loam. The substratum to a depth of 60 inches is pale olive extremely channery sandy loam. In some areas the surface layer is very gravelly loam, gravelly loam, or gravelly silt loam. In other areas the soil has less than 35 percent rock fragments in the subsoil and substratum or is not dominated by phyllite.

Included in this unit are small areas of Vanzandt, Squires, and Barneston soils and small areas of Heisler soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Heisler soil. Available water capacity also is moderate. The effective rooting depth is 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. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common understory plants are western swordfern, Oregongrape, red huckleberry, deer fern, Pacific trillium, bedstraw, and salal.

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, it is 127. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 176 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the

survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by Douglas fir and western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

**70-Hinker very channery silt loam, 5 to 30 percent slopes.**

This moderately deep, well drained soil is on high mountain shoulder slopes. It formed in a mixture of volcanic ash, loess, and colluvium derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 4,200 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. The surface layer is pinkish gray very channery silt loam 6 inches thick. The upper 5 inches of the subsoil is organic stained, dark brown very channery silt loam. The lower 10 inches is dark brown very channery loam. Phyllite is at a depth of about 21 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is very channery loam, very gravelly silt loam, or very gravelly loam. In other areas the soil has less than 6 percent organic carbon in the lower part of the subsoil, is 40 to 60 inches deep to phyllite, or has a less developed subsoil.

Included in this unit are small areas of Diobsud and Saar soils, soils that are 14 to 20 inches deep to phyllite, Rock outcrop, and Hinker soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Hinker soil. Available water capacity also is moderate. The 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. Among the trees of limited extent are Alaska cedar and mountain hemlock. The common understory plants are tall blue huckleberry, bunchberry dogwood, deer fern, western brackenfern, and salmonberry..

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 91. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-

aged stands of western hemlock is about 107 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, the snowpack limits the use of equipment and restricts access from November through May. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Phyllite, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

**71-Hinker very channery silt loam, 30 to 60 percent slopes.** This moderately deep, well drained soil is on high mountain shoulder slopes. It formed in a mixture of volcanic ash, loess, and colluvium derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 4,200 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. The surface layer is pinkish gray very channery silt loam 6 inches thick. The upper 5 inches of the subsoil is organic stained, dark brown very channery silt loam. The lower 10 inches is dark brown very channery loam and very

channery silt loam. Phyllite is at a depth of about 21 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is very channery loam, very gravelly silt loam, or very gravelly loam. In other areas the soil has less than 6 percent organic carbon in the lower part of the subsoil, is 40 to 60 inches deep to phyllite, or has a less developed subsoil.

Included in this unit are small areas of Diobsud and Saar soils, soils that are 14 to 20 inches deep to phyllite, Rock outcrop, and Hinker soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Hinker soil. Available water capacity also is moderate. The 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. Among the trees of limited extent are Alaska cedar and mountain hemlock. The common understory plants are tall blue huckleberry, bunchberry dogwood, deer fern, western brackenfern, and salmonberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 91. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 107 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Phyllite, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of

erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**72-Histosols, ponded, 0 to 1 percent slopes.** These very deep, very poorly drained soils are in backswamps on flood plains and on the edge of bodies of water. They formed in mixed organic material consisting of mosses, forbs, and shrubs over mineral material. The native vegetation is mainly shrubs, forbs, and trees. Elevation is 50 to 400 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

No single profile is representative of this map unit. In one of the more commonly observed ones, however, the surface layer is dark brown and dark grayish brown muck about 28 inches thick. The underlying material to a depth of 70 inches is gray silt loam. The depth to mineral material ranges from 16 to 50 inches. After rubbing, the fiber content ranges from 5 to 25 percent. Reaction ranges from extremely acid to medium acid in the organic material and from strongly acid to neutral in the mineral material. In some areas the surface layer is mucky silt loam or hemic material.

Included in this unit are small areas of ponded Bellingham or Pangborn soils and areas where Histosols have been partially drained. Included areas make up about 10 percent of the total acreage.

Permeability is moderate or moderately slow in the Histosols. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface from November through August. Runoff is ponded, and there is no hazard of erosion.

This unit is used for wildlife habitat.

This map unit is in capability subclass Vw.

**73-Hovde silt loam, 0 to 2 percent slopes.** This very deep, poorly drained soil is on marine terraces. It formed in marine sediments and gravelly coastal beach deposits. The native vegetation is mainly trees and shrubs. Elevation is 5 to 20 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface is covered with a mat of leaves and twigs 1 inch thick. The surface layer is very dark grayish brown, mottled silt loam 9 inches thick. The underlying material to a depth of 60 inches is very dark grayish brown and dark grayish brown very gravelly sand or very gravelly coarse sand. In some areas the surface layer is loam. In other areas the soil has less than 35 percent rock fragments in the substratum or has a surface layer that is 12 to 16 inches thick.

Included in this unit are small areas of Eliza and Tacoma soils and bodies of water. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the Hovde soil. Available water capacity is low. The effective rooting depth is limited by a high water table, which is at or near the surface from November through April during periods of high tide. Runoff usually is very slow, but the soil may be ponded in the winter. There is no hazard of erosion. This soil is subject to frequent, brief periods of flooding from November through April. It is subject to tidal inundation unless protected. Channeling and deposition are common along streambanks.

This unit is used mainly as woodland or for wildlife habitat. Red alder is the main woodland species. Among the trees of limited extent are western redcedar and black cottonwood. The common understory plants are salmonberry, Douglas spirea, rose, stinging nettle, and sedges.

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 in unmanaged, even-aged stands of red alder is about 92 cubic feet per acre per year, occurring at age 40.

The main limitations affecting: timber harvesting are the muddiness caused by seasonal wetness and the hazard of flooding. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rounded pebbles for road construction are readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying

out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The high water table and the flooding hinder root respiration and thus result in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitations are the high water table and the hazard of flooding. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitations on sites for septic tank absorption fields are the hazard of flooding, the seasonal wetness, and a poor filtering capacity. The seasonal high water table increases the likelihood that the absorption field will fail. Installing the absorption field in fill approved by the health district helps to compensate for these limitations.

This map unit is in capability subclass VIw.

#### **74-Hozomeen gravelly loam, 20 to 45 percent slopes.**

This shallow, moderately well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash, loess, and colluvium over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 3,200 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles and twigs 6 inches thick. When mixed to a depth of 4 inches, the surface layer is dark reddish brown gravelly loam. The upper 9 inches of the subsoil is dark reddish brown and dark brown very gravelly loam. The lower 5 inches is strong brown very gravelly loam. Dense glacial till that crushes to gravelly loam is at a depth of 18 inches. The depth to dense glacial till ranges from 14 to 20 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly silt loam or loam. In other areas the soil has less than 35 percent rock fragments in the subsoil

or has dominantly phyllite, serpentine, or dunite rock fragments in the subsoil and in the dense glacial till.

Included in this unit are small areas of Kindy, Getchell, Klawatti, Springsteen, and Clendenen soils, Rock outcrop, and Hozomeen soils that have slopes of more than 45 percent or less than 20 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the upper part of the Hozomeen soil and very slow in the dense glacial till. Available water capacity is low. The effective rooting depth is 14 to 20 inches. Water is perched above the dense glacial till from November through April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir and western redcedar. The common understory plants are red huckleberry, Oregongrape, salal, bunchberry dogwood, western brackenfern, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 114. On the basis of a 50-year site curve, it is estimated to be 80. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 168 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are snowpack, the slope, and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from December through April. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment or cable yarding systems can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Plant competition and the hazard of windthrow are the main concerns affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. A low soil temperature,

deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass Vle.

**75-Hydraquents, tidal, 0 to 1 percent slopes.** These very deep, poorly drained soils are on tidal flats. They formed in alluvium. The native vegetation is mainly saltgrass. Elevation is sea level. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

No single profile is representative of this map unit. In one of the more commonly observed ones, however, the surface layer is gray and olive gray fine sandy loam about 6 inches thick. The underlying material to a depth of 60 inches is gray and olive gray stratified silt loam, loam, and fine sandy loam. The content of clay ranges from 10 to 25 percent by weighted average. In some areas the soil has strata of sand or silty clay loam.

Included in this unit are small areas of water and Psammaquents. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Hydraquents. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface during periods of high tide throughout the year. These soils are subject to frequent, long periods of flooding during high tides throughout the year.

This unit is used for wildlife habitat or recreation.

This map unit is in capability subclass VIIw.

**76-Jackman gravelly silt loam, 30 to 60 percent slopes.** This very deep, well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash, colluvium, slope alluvium, and glacial drift derived dominantly from dunite. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 3,600 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 42 degrees

F, and the average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles and twigs 2 inches thick. When mixed to a depth of 9 inches, the surface layer is dark yellowish brown gravelly silt loam. The upper 6 inches of the subsoil is yellowish brown very gravelly silt loam. The lower 17 inches is strong brown very gravelly silt loam and yellowish brown very gravelly loam. The substratum to a depth of 60 inches is dark brown very gravelly loam. In some areas the surface layer is gravelly loam. In other areas the soil has a substratum of very gravelly loamy sand or has a more developed subsoil.

Included in this unit are small areas of Twinsi and Klawatti soils, Rock outcrop, and Jackman soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Jackman soil. Available water capacity is high. The effective rooting depth is 60 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. Among the trees of limited extent are Pacific silver fir and Alaska cedar. The common understory plants are tall blue huckleberry, deer fern, western brackenfern, and western rattlesnake plantain. Vegetation is somewhat stunted and sparse because of the toxicity of the dunite-derived soil.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying

out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, Pacific silver fir, or Alaska cedar seedlings, which are adapted to the toxicity of dunite soils. If seed trees are available, natural reforestation of cutover areas by western hemlock, Pacific silver fir, and Alaska cedar occurs periodically. Trees grow poorly and lack vigor on soils that are derived from dunite.

This map unit is in capability subclass VIIe.

**77-Jorgensen gravelly silt loam, 3 to 15 percent slopes.** This very deep, somewhat excessively drained soil is on outwash terraces. It formed in a mixture of volcanic ash, loess, and glacial outwash derived dominantly from dunite. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 3,100 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and rotting logs 18 inches thick. When mixed to a depth of 5 inches, the surface layer is brown gravelly silt loam. The upper 3 inches of the subsoil is organic stained, dark brown gravelly loam. The lower 11 inches is dark yellowish brown very gravelly sandy loam. The substratum to a depth of 60 inches is olive brown extremely gravelly loamy sand. The depth to extremely gravelly sand or loamy sand ranges from 10 to 25 inches. In some areas the surface layer is gravelly loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil.

Included in this unit are small areas of Jackman, Twinsi, and Klawatti soils and small areas of Jorgensen soils that have slopes of more than 15 percent or less

than 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Jorgensen soil and very rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 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. Among the trees of limited extent are mountain hemlock and Alaska cedar. The common understory plants are tall blue huckleberry, western brackenfern, deer fern, and western rattlesnake plantain. Vegetation is somewhat stunted and sparse because of the toxicity of the dunite-derived soil.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 84. On the basis of a 50-year site curve, it is estimated to be 60. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 95 cubic feet per acre per year, occurring at age 60. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, the snowpack limits the use of equipment and restricts access from November through May. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. Reforestation can be accomplished by

planting western hemlock, Pacific silver fir, or Alaska cedar seedlings, which are adapted to the toxicity of dunite soils. If seed trees are available, natural reforestation of cutover areas by western hemlock, Pacific silver fir, and Alaska cedar occurs periodically. Trees grow poorly and lack vigor on soils that are derived from dunite. Planting seedlings in the organic layer improves growth and vigor.

This map unit is in capability subclass VIe.

#### **78-Jug very gravelly loam, 3 to 15 percent slopes.**

This very deep, somewhat excessively drained soil is on outwash terraces. It formed in a mixture of volcanic ash and glacial outwash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 2,000 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F, and the average frost-free period is about 115 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 5 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown very gravelly loam. The upper 3 inches of the subsoil is strong brown very gravelly loam. The lower 16 inches is yellowish brown very gravelly sandy loam. The substratum to a depth of 60 inches is olive brown very gravelly loamy sand. The depth to very gravelly loamy sand ranges from 13 to 25 inches. In some areas the surface layer is very gravelly sandy loam. In other areas the soil has a substratum of very gravelly sandy loam, has a subsoil of very gravelly loamy sand, or has less than 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Oakes, Cupples, Sandun, and Sorensen soils and small areas of Jug soils that have slopes of more than 15 percent or less than 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Jug soil and very rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches. 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. Among the trees of limited extent are western redcedar and red alder. The common understory plants are red huckleberry, Oregon grape, salal, prince's pine, western swordfern, deer fern, ladyfern, vine maple, and western brackenfern.

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, it is 111 for western hemlock and 129 for Douglas fir. The highest

average growth rate in unmanaged, even-aged stands of western hemlock is 248 cubic feet per acre per year, occurring at age 50. For Douglas fir, it is 180 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, the snowpack limits the use of equipment and restricts access from January through March. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Seedling establishment and seedling mortality are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVe.

**79-Kickerville silt loam, 0 to 3 percent slopes.** This very deep, well drained soil is on outwash terraces. It formed in a mixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark brown silt loam 9 inches thick. The upper 13 inches of the subsoil is dark yellowish brown silt loam. The lower 10 inches is dark yellowish brown very gravelly loam. The substratum to a depth of 60 inches is very gravelly sand. It is variegated but is dominantly olive brown and dark grayish brown. The depth to very gravelly sand or extremely gravelly loamy sand ranges from 20 to 36 inches. In some areas the surface layer is loam, gravelly silt loam, or gravelly loam. In other areas the soil has a gravelly subsoil. In places the substratum has 15 to 35 percent rock fragments, has 5 to 15 percent cobbles, or is very gravelly sandy loam.

Included in this unit are small areas of Barnhardt, Birchbay, Clipper, Laxton, Shalcar, Fishtrap, and Everett soils and small areas of Kickerville soils that have a stony surface or have slopes of more than 3

percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Kickerville soil and very rapid in the substratum. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is very slow, and there is no hazard of erosion.

This unit is used mainly for hay and pasture or as cropland. It also is used as woodland and as a site for homes.

This unit is suited to hay and pasture. It has few limitations for this use.

The main limitation in the areas used as cropland is the low available water capacity in the substratum. In summer, irrigation is required for maximum production. The principal crops grown are potatoes, corn silage, and raspberries. If irrigated, this unit is suited to all crops commonly grown in the survey area.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common understory plants are western swordfern, salal, red huckleberry, Oregongrape, and creambush oceanspray.

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, it is 119. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 157 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rounded pebbles for road construction are readily available. Logging roads require suitable surfacing for year-around use.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is well suited to homesite development. If used as a base for roads and streets, the soil can be mixed with the underlying sand and gravel, which can increase the strength and stability of the soil. In shallow

excavations special retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to compensate for this limitation.

This map unit is in capability subclass IIc.

**80-Kickerville silt loam, 3 to 8 percent slopes.** This very deep, well drained soil is on outwash terraces. It formed in a mixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark brown silt loam 9 inches thick. The upper 13 inches of the subsoil is dark yellowish brown silt loam. The lower 10 inches is dark yellowish brown very gravelly loam. The substratum to a depth of 60 inches is very gravelly sand. It is variegated but is dominantly olive brown and dark grayish brown. The depth to very gravelly sand or extremely gravelly loamy sand ranges from 20 to 36 inches. In some areas the surface layer is loam, gravelly silt loam, or gravelly loam. In other areas the soil has a gravelly subsoil. In places the substratum has 15 to 35 percent rock fragments, has 5 to 15 percent cobbles, or is very gravelly sandy loam.

Included in this unit are small areas of Barnhardt, Birchbay, Clipper, Laxton, Shalcar, Fishtrap, and Everett soils and small areas of Kickerville soils that have a stony surface or have slopes of more than 8 percent or less than 3 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Kickerville soil and very rapid in the substratum. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture or as cropland. It also is used as woodland and as a site for homes.

This unit is suited to hay and pasture. It has few limitations for this use.

The main limitation in the areas used as cropland is the low available water capacity. In summer, irrigation is required for maximum production. The principal crops grown are potatoes, corn silage, and raspberries. If irrigated, this unit is suited to all crops commonly grown in the survey area.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common understory plants

are western swordfern, salal, red huckleberry, Oregongrape, and creambush oceanspray.

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, it is 119. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 157 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is well suited to homesite development. It has few limitations. If used as a base for roads and streets, the soil can be mixed with the underlying sand and gravel, which can increase the strength and stability of the soil. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to compensate for this limitation.

This map unit is in capability subclasses IIe, nonirrigated, and IIIe, irrigated.

**81-Kickerville silt loam, 8 to 15 percent slopes.** This very deep, well drained soil is on outwash terraces. It formed in a mixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1.5 inches thick. The surface layer is very dark brown silt loam 3 inches thick. The

upper 16 inches of the subsoil is dark yellowish brown loam. The lower 5 inches is dark yellowish brown very gravelly loam. The substratum to a depth of 60 inches is extremely gravelly sand. It is variegated but is dominantly dark yellowish brown and olive brown. The depth to very gravelly sand or extremely gravelly sand ranges from 20 to 36 inches. In some areas the surface layer is loam, gravelly silt loam, or gravelly loam. In other areas the soil has a gravelly subsoil. In places the substratum is very gravelly sandy loam, has 15 to 35 percent rock fragments, or has 5 to 15 percent cobbles.

Included in this unit are small areas of Barnhardt, Birchbay, Laxton, and Everett soils and small areas of Kickerville soils that have a stony surface or have slopes of more than 15 percent or less than 8 percent. These included areas make up about 10 percent of the total acreage. Also included are soils that have slopes of 15 to 30 percent. These soils are in narrow, elongated areas along terrace escarpments. They make up an additional 3 percent of the total unit.

Permeability is moderate in the upper part of the Kickerville soil and very rapid in the substratum. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly for hay and pasture or as woodland. It also is used as a site for homes.

The main limitations in the areas used for hay and pasture are the low available water capacity and the hazard of water erosion during periods of reestablishment. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common understory plants are western swordfern, salal, red huckleberry, Oregongrape, and creambush oceanspray.

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, it is 119. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 157 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high

degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation affecting homesite development is the slope. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. If used as a base for roads and streets, the soil can be mixed with the underlying sand and gravel, which can increase the strength and stability of the soil. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to compensate for this limitation. The slope affects the installation of septic tank absorption fields. The absorption lines should be installed on the contour.

This map unit is in capability subclasses IIIe, nonirrigated, and IVe, irrigated.

**82-Kickerville-Urban land complex, 0 to 3 percent slopes.** This map unit is on outwash terraces. The native vegetation is mainly conifers and shrubs. Elevation is 60 to 100 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 50 percent Kickerville silt loam and 30 percent Urban land. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Chuckanut, Clipper, Birchbay, Nati, Everett, and Whatcom soils and small areas of Kickerville soils that have slopes of more than 3 percent. Included areas make up about 20 percent of the total acreage.

The Kickerville soil is very deep and well drained. It formed in a mixture of loess and volcanic ash over glacial outwash. Typically, the surface layer is dark brown silt loam 9 inches thick. The upper 13 inches of the subsoil is dark yellowish brown silt loam. The lower 10 inches is dark yellowish brown very gravelly loam. The substratum to a depth of 60 inches is very gravelly sand. It is variegated but is dominantly olive brown and

dark grayish brown. The depth to very gravelly sand ranges from 20 to 36 inches. In some areas the surface layer is loam, gravelly silt loam, or gravelly loam. In other areas the soil has a gravelly subsoil. In places the substratum has 15 to 35 percent rock fragments, has 5 to 15 percent cobbles, or is very gravelly sandy loam.

Permeability is moderate in the upper part of the Kickerville soil and very rapid in the substratum. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is very slow, and there is no hazard of erosion.

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

The Kickerville soil is used for lawns, gardens, parks, or vacant lots.

This unit is well suited to homesite development. It has few limitations. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. If used as a base for roads and streets, the Kickerville soil can be mixed with the underlying sand and gravel, which can increase the strength and stability of the soil. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to compensate for this limitation.

The Kickerville soil is in capability subclass IIc. The Urban land is in capability subclass VIIIs.

**83-Kindy gravelly silt loam, 8 to 30 percent slopes.** This moderately deep, moderately well drained soil is on high mountain back slopes and plateaus. It formed in a mixture of volcanic ash, loess, and colluvium over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,700 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 105 days.

Typically, the surface is covered with a mat of needles and twigs 6 inches thick. When mixed to a depth of 4 inches, the surface layer is brown gravelly silt loam. The upper 7 inches of the subsoil is brown very gravelly silt loam. The lower 14 inches is yellowish brown very gravelly loam. Dense glacial till that crushes to very gravelly loam is at a depth of 25 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly loam, very gravelly loam, or very gravelly silt loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, has dominantly phyllite or dunite rock fragments

in the subsoil and in the dense glacial till, or is 40 to 60 inches deep over bedrock or dense glacial till.

Included in this unit are small areas of Hartnit, Crinker, Hozomeen, Klawatti, and Springsteen soils, Rock outcrop, and Kindy soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Kindy soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Douglas fir, Pacific silver fir, and western redcedar. The common understory plants are tall blue huckleberry, salmonberry, deer fern, western brackenfern, red huckleberry, and salal.

On the basis of a 100-year site curve, the mean site index is 135 for western hemlock and 120 for Douglas fir. On the basis of a 50-year site curve, it is 96 for western hemlock and 95 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 209 cubic feet per acre per year, occurring at age 50. For Douglas fir, it is 115 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from December through April. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the

survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

#### **84-Kindy gravelly silt loam, 30 to 60 percent slopes.**

This moderately deep, moderately well drained soil is on high mountain back slopes and plateaus. It formed in a mixture of volcanic ash, loess, and colluvium over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,700 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 105 days.

Typically, the surface is covered with a mat of needles and twigs 6 inches thick. When mixed to a depth of 4 inches, the surface layer is brown gravelly silt loam. The upper 7 inches of the subsoil is brown very gravelly silt loam. The lower 14 inches is yellowish brown very gravelly loam. Dense glacial till that crushes to very gravelly loam is at a depth of 25 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly loam, very gravelly loam, or very gravelly silt loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, has dominantly phyllite or dunite rock fragments in the subsoil and in the dense glacial till, or is 40 to 60 inches deep over bedrock or dense glacial till.

Included in this unit are small areas of Hartnit, Crinker, Hozomeen, Klawatti, and Springsteen soils, Rock outcrop, and Kindy soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Kindy soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Douglas fir, Pacific silver fir, and western redcedar. The common understory plants are tall blue huckleberry, salmonberry, deer fern, western brackenfern, red huckleberry, and salal.

On the basis of a 100-year site curve, the mean site index is 135 for western hemlock and 120 for Douglas fir. On the basis of a 50-year site curve, it is 96 for western hemlock and 95 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 209 cubic feet per acre per year, occurring at age 50. For Douglas fir, it is 115 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from December through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and

Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

#### **85-Kindy-Oso complex, 5 to 40 percent slopes.**

This map unit is on high mountain back slopes and plateaus. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,700 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 105 days.

This unit is 50 percent Kindy gravelly silt loam and 35 percent Oso silt loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of soils that are less than 20 inches deep to dense glacial till or bedrock, Rock outcrop, soils that are similar to the Kindy or Oso soil but are deeper than 40 inches, and Kindy and Oso soils that have slopes of more than 40 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

The Kindy soil is moderately deep and moderately well drained. It formed in a mixture of volcanic ash, loess, and colluvium over glacial till. Typically, the surface is covered with a mat of needles and twigs 1 inch thick. The surface layer is dark brown gravelly silt loam 4 inches thick. The upper 6 inches of the subsoil is dark reddish brown gravelly silt loam. The lower 17 inches is dark brown and dark reddish brown very gravelly silt loam. Dense glacial till that crushes to very gravelly loam is at a depth of 27 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly loam or very gravelly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil or is 40 to 60 inches deep to dense glacial till.

Permeability is moderate in the upper part of the Kindy soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through April. Runoff is slow, and the hazard of water erosion is slight.

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

derived from metasedimentary rocks. Typically, the surface is covered with a mat of needles and twigs 4 inches thick. When mixed to a depth of 3 inches, the surface layer is dark reddish brown silt loam. The upper 11 inches of the subsoil is dark brown gravelly silt loam. The lower 24 inches is dark yellowish brown gravelly silt loam. Metasedimentary rock is at a depth of about 38 inches. The depth to bedrock ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam. In other areas the soil has 15 to 35 percent pebbles throughout the subsoil or is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Oso soil. Available water capacity is moderate. The 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. Among the trees of limited extent are Douglas fir, Pacific silver fir, and western redcedar. The common understory plants are tall blue huckleberry, salmonberry, deer fern, western brackenfern, red huckleberry, and salal.

On the basis of a 100-year site curve, the mean site index on the Kindy soil is 135 for western hemlock and 120 for Douglas fir. On the basis of a 50-year site curve, it is 96 for western hemlock and 95 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 209 cubic feet per acre per year, occurring at age 50. For Douglas fir, it is 115 cubic feet per acre per year, occurring at age 60.

On the basis of a 100-year site curve, the mean site index for western hemlock on the Oso soil is 129. On the basis of a 50-year site curve, it is 93. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 198 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack and muddiness caused by the seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from December through April. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a moderate degree of compaction when the soils are moist and a moderate degree of puddling when the soils are wet. Steep skid trails and firebreaks are

subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till or the bedrock, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

The Kindy and Oso soils are in capability subclass VIe.

**86-Klawatti very gravelly loam, 30 to 60 percent slopes.** This moderately deep, well drained soil is on high mountain shoulder slopes and ridges. It formed in volcanic ash, slope alluvium, and colluvium derived dominantly from dunite. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 4,200 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, twigs, and bark 7 inches thick. When mixed to a depth of 7 inches, the surface layer is dark yellowish brown very gravelly loam. The subsoil is dark yellowish brown extremely gravelly silt loam 18 inches thick. Dunite is at a depth of about 25 inches. The depth to bedrock ranges from 20 to 40 inches. In some areas the surface layer is very gravelly silt loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Twinsi, Jackman, and Edfro soils, Rock outcrop, soils that are shallow to dunite, and Klawatti soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Klawatti soil. Available water capacity also is moderate. The 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. Among the trees of limited extent are Pacific silver fir, Alaska cedar, and mountain hemlock. The common understory plants are blueleaved huckleberry, red huckleberry, prince's pine, and western brackenfern. Vegetation is somewhat stunted and sparse because of the toxicity of the dunite-derived soil.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Soil creep is common on this unit.

Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, Pacific silver fir, or Alaska cedar seedlings, which are adapted to the toxicity of dunite soils. If seed trees are available, natural reforestation of cutover areas by western

hemlock, mountain hemlock, Pacific silver fir, and Alaska cedar occurs periodically. Trees grow poorly and lack vigor on soils that are derived from dunite. Planting seedlings in the organic layer improves growth and vigor. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**87-Klawatti very gravelly loam, serpentine, 10 to 30 percent slopes.** This moderately deep, well drained soil is on high mountain shoulder slopes and ridges. It formed in volcanic ash, colluvium, and slope alluvium derived dominantly from serpentine. The native vegetation is mainly conifers and shrubs. Elevation is 2,000 to 4,300 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 7 inches, the surface layer is dark yellowish brown very gravelly loam. The subsoil is dark yellowish brown extremely gravelly silt loam 18 inches thick. Serpentine is at a depth of about 25 inches. The depth to serpentine ranges from 20 to 40 inches. In some areas the surface layer is very gravelly silt loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Edfro, Twinsi, Crinker, Jackman, and Saar soils, Rock outcrop, soils that are shallow to serpentine, and Klawatti soils that have slopes of more than 30 percent or less than 10 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Klawatti soil. Available water capacity is moderate. The 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. Among the trees of limited extent are Pacific silver fir, Alaska cedar, and mountain hemlock. The common understory plants are blueleaved huckleberry, red huckleberry, prince's pine, and western brackenfern. Vegetation is somewhat stunted and sparse because of the toxicity of the serpentine-derived soil.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds

are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is snowpack. During an average year, the snowpack limits the use of equipment and restricts access from November through May. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, Pacific silver fir, or Alaska cedar seedlings, which are adapted to the toxicity of serpentine soils. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, Pacific silver fir, and Alaska cedar occurs periodically. Trees grow poorly and lack vigor on soils that are derived from serpentine. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

**88-Klawatti very gravelly loam, serpentine, 30 to 60 percent slopes.** This moderately deep, well drained soil is on high mountain shoulder slopes and ridges. It formed in volcanic ash, colluvium, and slope alluvium derived dominantly from serpentine. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 4,300 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 100 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 7 inches, the surface layer is dark yellowish brown very gravelly loam. The subsoil is dark yellowish brown extremely gravelly silt loam 18 inches thick. Serpentine is at a depth of about 25 inches. The

depth to serpentine ranges from 20 to 40 inches. In some areas the surface layer is very gravelly silt loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Edfro, Twinsi, Crinker, Jackman, and Saar soils, Rock outcrop, soils that are shallow to serpentine, and Klawatti soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Klawatti soil. Available water capacity is moderate. The 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. Among the trees of limited extent are Pacific silver fir, Alaska cedar, and mountain hemlock. The common understory plants are blueleaved huckleberry, red huckleberry, princes pine, and western brackenfern. Vegetation is somewhat stunted and sparse because of the toxicity of the serpentine-derived soil.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the hazard of slumping, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. This unit is prone to landslides and deep-seated rotational slumping because of the deep fractures in the serpentine that have resulted from faulting planes in the rock. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks

are subject to rifling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, Pacific silver fir, or Alaska cedar seedlings, which are adapted to the toxicity of serpentine soils. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, Pacific silver fir, and Alaska cedar occurs periodically. Trees grow poorly and lack vigor on soils that are derived from serpentine. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**89-Klawatti-Rock outcrop complex, 60 to 80 percent slopes.** This map unit is on high mountain shoulder slopes and ridges. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 4,300 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 100 days.

This unit is 55 percent Klawatti very gravelly loam and 25 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Twinsi, Crinker, Jackman, and Saar soils, soils that are shallow to serpentine, stony areas, and Klawatti soils that have slopes of less than 60 percent. Included areas make up about 20 percent of the total acreage.

The Klawatti soil is moderately deep and well drained. It formed in volcanic ash, colluvium, and slope alluvium derived dominantly from serpentine. Typically, the surface is covered with a mat of needles and twigs 2 inches thick. When mixed to a depth of 7 inches, the surface layer is dark yellowish brown very gravelly loam. The subsoil is dark yellowish brown extremely gravelly loam 13 inches thick. The substratum is dark yellowish brown very gravelly loam 8 inches thick.

Serpentine is at a depth of about 28 inches. The depth to serpentine ranges from 20 to 40 inches. In some areas the surface layer is very gravelly silt loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Klawatti soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is serpentine, although in some areas it is phyllite. It is hard and generally unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, mountain hemlock, and Alaska cedar. The common understory plants are blueleaved huckleberry, red huckleberry, prince's pine, and western brackenfern. Vegetation is somewhat stunted and sparse because of the toxicity of the serpentine-derived soil.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60. Yields are reduced by the extent of the Rock outcrop. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the hazard of slumping, the Rock outcrop, the slope, snowpack, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. This unit is prone to landslides and deep-seated rotational slumping because of the deep fractures in the serpentine that have resulted from faulting planes in the rock. Cable yarding systems generally are used on this unit. The pattern of the Rock outcrop on the landscape results in a discontinuous slope, which hinders the use of cable yarding systems. The trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity.

Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Carefully laying out roads

and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit.

Reforestation can be accomplished by planting western hemlock, Pacific silver fir, or Alaska cedar seedlings, which are adapted to the toxicity of serpentine soils. Because of the Rock outcrop and the slope, planting seedlings by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, Pacific silver fir, and Alaska cedar occurs periodically. Trees grow poorly and lack vigor on soils that are derived from serpentine. The Rock outcrop prevents the even distribution of reforestation. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the Klawatti soil is wet and winds are strong.

The Klawatti soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

#### **90-Kline gravelly sandy loam, 2 to 8 percent slopes.**

This very deep, moderately well drained soil is on alluvial fans. It formed in mixed alluvium. It is partially protected from flooding. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 1,000 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, when mixed to a depth of 9 inches, the surface layer is dark brown and olive brown gravelly sandy loam. The upper 11 inches of the underlying material is dark brown extremely gravelly loamy sand. The lower part to a depth of 60 inches is dark grayish brown stratified very gravelly loamy sand and very gravelly sand. Depth to the underlying material ranges from 8 to 20 inches. In some areas the surface layer is gravelly loam. In other areas the soil has strata within the underlying material with less than 35 percent rock

fragments or has 15 to 35 percent phyllite rock fragments.

Included in this unit are small areas of Sehome, Whatcom, and Briscot soils and small areas of Kline soils that are not protected from flooding or have slopes of more than 8 percent or less than 2 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Kline soil and very rapid in the underlying material. Available water capacity is low. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 3 to 5 feet from January through March. Runoff is slow, and the hazard of water erosion is slight. In most areas this soil is subject to rare flooding. In some unprotected areas, however, it is subject to occasional, very brief periods of flooding from December through March.

This unit is used mainly for hay and pasture or as woodland. It also is used as cropland and as a site for homes.

The main limitation in the areas used for hay and pasture is the low available water capacity. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, and western hemlock. The common understory plants are salal, red huckleberry, western brackenfern, western swordfern, trailing blackberry, and Oregongrape.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 124. On the basis of a 50-year site curve, it is estimated to be 106. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 121 cubic feet per acre per year, occurring at age 70.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are somewhat soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and displacement.

Seedling establishment and seedling mortality are the main concerns affecting timber production. A low

content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. The survival rate of seedlings may be low in areas where flooding occurs.

The main limitations in the areas used as cropland are the low available water capacity and the seasonal high water. The principal crop is corn silage. If irrigated, this soil is suited to other climatically adapted crops. Because of the inherent low fertility, this unit requires proportionately more fertilizer than most other soils in the survey area to produce similar yields. The pebbles in the surface layer make tillage difficult and can cause equipment damage. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water. In summer, irrigation is required for maximum production.

The main limitation for homesite development is the hazard of flooding. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitations on sites for septic tank absorption fields are a poor filtering capacity in the substratum and the seasonal high water table. Septic tank absorption fields may not function properly during rainy periods because of the wetness. These limitations can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope.

This map unit is in capability subclass IVs.

**91-Kulshan loam, 5 to 30 percent slopes.** This moderately deep, well drained soil is on mountain back slopes and ridges. It formed in volcanic ash, loess, colluvium, and slope alluvium derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 5,000 feet. The average annual precipitation is about 100 inches, the average annual air temperature is about 40 degrees F, and the average frost-free period is about 85 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and bark 7 inches thick. When mixed to a depth of 8 inches, the surface layer is dark red loam. The upper 6 inches of the subsoil is organic stained, yellowish red gravelly loam. The lower 16

inches is yellowish red and dark reddish brown gravelly loam and cobbly loam. Sandstone is at a depth of about 30 inches. The depth to sandstone ranges from 20 to 40 inches. In some areas the surface layer is silt loam or gravelly loam. In other areas the soil has a very gravelly subsoil or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Shuksan, Potchub, and Gallup soils, soils that are less than 20 inches deep over bedrock, poorly drained mineral and organic soils in depressions, Rock outcrop, and Kulshan soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kulshan soil. Available water capacity also is moderate. The 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. Among the trees of limited extent is mountain hemlock. The common understory plants are blueleaved huckleberry, bunchberry dogwood, and longtube twinflower..

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 93. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 110 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitation affecting timber harvesting is snowpack. During an average year, the snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and

gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VI.

**92-Kulshan loam, 30 to 60 percent slopes.** This moderately deep, well drained soil is on mountain back slopes and ridges. It formed in volcanic ash, loess, colluvium, and slope alluvium derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 5,000 feet. The average annual precipitation is about 100 inches, the average annual air temperature is about 40 degrees F, and the average frost-free period is about 85 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and bark 7 inches thick. When mixed to a depth of 8 inches, the surface layer is dark red loam. The upper 6 inches of the subsoil is organic stained, yellowish red gravelly loam. The lower 16 inches is yellowish red and dark reddish brown gravelly loam and cobbly fine sandy loam. Sandstone is at a depth of about 30 inches. The depth to sandstone ranges from 20 to 40 inches. In some areas the surface layer is silt loam or gravelly loam. In other areas the soil has a very gravelly subsoil or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Shuksan, Potchub, and Gallup soils, soils that are less than 20 inches deep over bedrock, poorly drained mineral and organic soils in depressions, Rock outcrop, and Kulshan soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Kulshan soil. Available water capacity also is moderate. The 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. Among the trees of limited extent is mountain hemlock. The common understory plants are blueleaved huckleberry,

bunchberry dogwood, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 93. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 110 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Soil creep is common on this unit.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**93-Labounty silt loam, 0 to 2 percent slopes.** This very deep, poorly drained soil is in depressions on glaciomarine drift plains. It formed in glaciomarine drift with an admixture of loess and volcanic ash. The native vegetation is mainly trees and shrubs. Elevation is 50 to 600 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown silt loam 12 inches thick. The upper

3 inches of the subsoil is dark grayish brown, mottled silt loam. The lower 14 inches is grayish brown, mottled silt loam. The substratum to a depth of 60 inches is grayish brown and light brownish gray loam. In some areas the surface layer is loam. In other areas the soil has 10 to 18 percent or 35 to 45 percent clay in the subsoil and substratum, has lenses of sand in the substratum, or has 5 to 15 percent cobbles in the substratum.

Included in this unit are small areas of Whatcom and Hale soils and small areas of Labounty soils that have been artificially drained. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Labounty soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface from November through May. Runoff is very slow, and there is no hazard of erosion.

This unit is used as woodland. Red alder is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and Douglas fir. The common understory plants are salmonberry, western brackenfern, western swordfern, red huckleberry, sweetscented bedstraw, skunkcabbage, trailing blackberry, and Douglas spirea.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The high water table hinders root respiration and thus results in a low seedling survival rate.

Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western

hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings.

Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIw.

#### **94-Labounty silt loam, drained, 0 to 2 percent slopes.**

This very deep, poorly drained soil is in depressions on glaciomarine drift plains. It has been artificially drained. It formed in glaciomarine drift with an admixture of loess and volcanic ash. The native vegetation is mainly trees and shrubs. Elevation is 50 to 600 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is very dark grayish brown silt loam 10 inches thick. The upper 6 inches of the subsoil is grayish brown and light brownish gray, mottled loam. The lower 19 inches is grayish brown, olive gray, and light olive gray, mottled loam. The substratum to a depth of 60 inches is gray loam. In some areas the surface layer is loam. In other areas the soil has a surface layer that is 5 to 8 inches thick or is light colored. In places the substratum has lenses of sandy material, has 10 to 18 percent or 35 to 45 percent clay, or has 5 to 10 percent cobbles, stones, or boulders.

Included in this unit are small areas of Whatcom, Bellingham, Hale, and Birchbay soils, Shalcar soils in depressions, and undrained Labounty soils. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Labounty soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 3 feet from November through May. Runoff is very slow, and there is no hazard of erosion.

This unit is used for hay and pasture or as cropland. The main limitations in the areas used for hay and pasture are the high water table and the moderately slow permeability. The principal crop is corn silage. The dominant method of drainage in the areas used for hay and pasture is open ditches. Maintaining artificial drainage systems permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water. Most crops common to the survey area can be grown if the drainage system is adequate. Returning all crop residue

to the soil and including grasses, legumes, or grass-legume mixtures in the cropping sequence help to maintain fertility and tilth. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet.

This unit has potential as woodland. 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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

If this unit is used for homesite development, the main limitation is the high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the moderately slow permeability and the high water table. Installing absorption lines that are longer than normal helps to overcome these limitations.

This map unit is in capability subclass IIw.

**95-Larush silt loam, 0 to 2 percent slopes.** This very deep, well drained soil is on river terraces. It formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 200 to 500 feet. The average annual precipitation is about 65 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 180 days.

Typically, the surface layer is very dark grayish brown silt loam 7 inches thick. The upper 18 inches of the underlying material is very dark grayish brown and dark grayish brown silt loam. The lower part to a depth of 60 inches is dark grayish brown sand and fine sand with thin strata of silt loam. The depth to sand ranges from 15 to 30 inches. In some areas the surface layer is loam or fine sandy loam. In other areas the substratum is stratified with sandy loam or is gravelly.

Included in this unit are small areas of Briscot, Barneston, Mt. Vernon, Oridia, Bellingham, and Shalcar soils and Riverwash. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Larush soil. Available water capacity also is moderate. The effective rooting depth is 60 inches. Runoff is very slow, and there is no hazard of erosion. In most areas this soil is subject to occasional, brief periods of flooding from November through April. Some unprotected areas, however, are subject to frequent, brief periods of flooding during this period. Channeling and deposition are common along streambanks.

This unit is used for hay and pasture, as woodland, or as cropland. The main limitation when used for hay and pasture is the hazard of flooding. Proper stocking rates, pasture rotation, and restricted grazing during wet

periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

This unit is suited to cropland. It has few limitations. The principal crops are corn silage and small grain. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common understory plants are western swordfern, western brackenfern, vine maple, trailing blackberry, and longtube twinflower.

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, it is estimated to be 131. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 185 cubic feet per acre per year, occurring at age 60.

The main limitations for timber harvesting are the occasional flooding and the muddiness caused by seasonal wetness. These limit the use of equipment to dry periods. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. The occasional flooding hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

If this unit is used for homesite development, the main limitation is the hazard of flooding. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings and onsite sewage disposal systems from the flooding.

This map unit is in capability subclass IIw.

**96-Laxton loam, 0 to 3 percent slopes.** This very deep, moderately well drained soil is on outwash terraces. It formed in loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark yellowish brown loam 9 inches thick. The subsoil is dark brown and dark yellowish brown silt loam 14 inches thick. The upper 9 inches of the substratum is olive brown, mottled loamy sand. The lower part to a depth of 60 inches is mottled sand. It is variegated but is dominantly olive brown, light brownish gray, and dark grayish brown. The depth to sand ranges from 20 to 40 inches. In some areas the surface layer is silt loam or sandy loam. In other areas the soil has a weakly cemented subsoil or substratum, has a combined surface layer and subsoil thickness of 10 to 20 inches, or has a water table below a depth of 3.5 feet.

Included in this unit are small areas of Hale and Yelm soils and small areas of soils that are similar to the Laxton soil but have a water table at a depth of 1.0 to 2.5 feet or have slopes of more than 3 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Laxton soil and very rapid in the substratum. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 2.5 to 3.5 feet from November through April. Runoff is very slow, and there is no hazard of erosion.

This unit is used mainly for hay and pasture, as cropland, or as woodland. It also is used as a site for homes.

The main limitation in the areas used for hay and pasture is the seasonal high water table. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion.

This unit is suited to cropland. It has few limitations. The principal crops are raspberries, strawberries, and sweet corn. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are western swordfern, salal, Oregongrape, vine maple, red huckleberry, and western brackenfern.

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, it is estimated to be 120. The highest average growth rate, in unmanaged, even-

aged stands of Douglas fir is about 170 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation affecting homesite development is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the seasonal high water table and a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to compensate for these limitations.

This map unit is in capability subclass IIw.

**97-Laxton loam, 3 to 8 percent slopes.** This very deep, moderately well drained soil is on outwash terraces. It formed in loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark yellowish brown loam 9 inches thick. The subsoil is dark brown and dark yellowish brown silt loam 14 inches thick. The upper 9 inches of the substratum is olive brown, mottled loamy sand. The lower part to a depth of 60 inches is mottled sand. It is variegated but is dominantly olive brown, light brownish gray, and dark grayish brown. The depth to

sand ranges from 20 to 40 inches. In some areas the surface layer is silt loam or sandy loam. In other areas the soil has a weakly cemented subsoil or substratum or has a water table below a depth of 3.5 feet. In places the combined thickness of the surface layer and subsoil is 10 to 20 inches.

Included in this unit are small areas of Hale and Yelm soils and small areas of soils that are similar to the Laxton soil but have a water table at a depth of 1.0 to 2.5 feet or have slopes of more than 8 percent or less than 3 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Laxton soil and very rapid in the substratum. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 2.5 to 3.5 feet from November through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture, as cropland, or as woodland. It also is used as a site for homes.

The main limitation in the areas used for hay and pasture is the seasonal high water. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

This unit is suited to cropland. It has few limitations. This soil is well suited to raspberries, strawberries, and sweet corn. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are western swordfern, salal, Oregon grape, vine maple, red huckleberry, and western brackenfern.

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, it is estimated to be 120. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 170 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high

degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation affecting homesite development is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitations on sites for septic tank absorption fields are the seasonal high water table and a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to compensate for these limitations.

This map unit is in capability subclasses IIe, nonirrigated, and IIIe, irrigated.

**98-Laxton loam, 8 to 15 percent slopes.** This very deep, moderately well drained soil is on outwash terraces. It formed in loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark yellowish brown loam 11 inches thick. The subsoil is yellowish brown loam 25 inches thick. The upper 14 inches of the substratum is olive brown, mottled sand. The lower part to a depth of 60 inches is mottled sand. It is variegated but is dominantly light olive brown. The depth to sand ranges from 20 to 40 inches. In some areas the surface layer is silt loam or sandy loam. In other areas the soil has a weakly cemented subsoil or substratum, has a water table below a depth of 3.5 feet, or has more than 35 percent rock fragments in the substratum. In places the combined thickness of the surface layer and subsoil is 10 to 20 inches.

Included in this unit are small areas of Yelm soils and small areas of soils that are similar to the Laxton soil but have a water table at a depth of 1 to 2 feet or

have slopes of more than 15 percent or less than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Laxton soil and very rapid in the substratum. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 2.5 to 3.5 feet from November through April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly for hay and pasture or as woodland. It also is used as a site for homes.

The main limitations in the areas used for hay or crops are the seasonal high water table and the hazard of erosion during periods of reestablishment. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are western swordfern, salal, Oregongrape, vine maple, red huckleberry, and western brackenfern.

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, it is estimated to be 120. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 170 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting, during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the

establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitations affecting homesite development are the seasonal high water table and the slope. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the seasonal high water table and a poor filtering capacity in the substratum. The slope affects the installation of septic tank absorption fields. The absorption lines should be installed on the contour. Installing the absorption field in fill approved by the health district helps to compensate for these limitations.

This map unit is in capability subclasses IIIe, nonirrigated, and IVe, irrigated.

**99-Lynden sandy loam, 0 to 3 percent slopes.** This very deep, well drained soil is on outwash terraces. It formed in loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark brown sandy loam 8 inches thick. The subsoil is dark brown sandy loam 10 inches thick. The substratum is variegated sand. The upper 12 inches is dominantly very dark grayish brown, and the lower part to a depth of 60 inches is dominantly dark grayish brown. The depth to sand ranges from 14 to 24 inches. In some areas the surface layer is loam. In other areas the soil has 15 to 25 percent pebbles in the substratum. In some places the lower part of the subsoil, the substratum, or both are weakly cemented, mottled, or both. In other places the combined thickness of the surface layer and subsoil is 24 to 36 inches or 8 to 14 inches.

Included in this unit are small areas of Hale, Tromp, and Lynnwood soils and small areas of Lynden soils that have slopes of more than 3 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Lynden soil and very rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is very slow, and there is no hazard of water erosion.

This unit is used mainly for hay and pasture, as cropland, or as a site for homes. It also is used as woodland.

The main limitation in the areas used for hay and pasture is the moderate available water capacity.

The main limitations in the areas used as cropland are the moderate available water capacity and the hazard of erosion. The principal crops are raspberries, carrots, and corn silage. Moisture retention can be improved by mulching, rotating legumes with grain, and leaving residue on slopes. Drip irrigation is the most suitable method of applying water for crop production. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock and red alder. The common understory plants are western swordfern, salal, Oregongrape, vine maple, western brackenfern, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 146. On the basis of a 50-year site curve, it is 112. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 153 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the mudiness caused by seasonal wetness. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when moist and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and displacement.

Seedling establishment is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is suited to homesite development. It has few limitations. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the

health district helps to compensate for this limitation.

This map unit is in capability subclass III<sub>s</sub>.

**100-Lynden sandy loam, 3 to 8 percent slopes.** This very deep, well drained soil is on outwash terraces. It formed in loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark brown sandy loam 8 inches thick. The subsoil is dark brown sandy loam 10 inches thick. The substratum is variegated sand. The upper 12 inches is dominantly very dark grayish brown, and the lower part to a depth of 60 inches is dominantly dark grayish brown. The depth to sand ranges from 14 to 24 inches. In some areas the surface layer is loam. In other areas the soil has 15 to 25 percent pebbles in the substratum. In some places the lower part of the subsoil, the substratum, or both are weakly cemented, mottled, or both. In other places the combined thickness of the surface layer and subsoil is 24 to 36 inches or 8 to 14 inches.

Included in this unit are small areas of Hale, Tromp, and Lynnwood soils and small areas of Lynden soils that have slopes of more than 8 percent or less than 3 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Lynden soil and very rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture, as cropland, or as woodland. It also is used as a site for homes.

The main limitation in the areas used for hay and pasture is the moderate available water capacity.

The main limitations in the areas used as cropland are the moderate available water capacity and the hazard of erosion. The principal crops are raspberries, carrots, and corn silage. Moisture retention can be improved by mulching, rotating legumes with grain, and leaving residue on slopes. Drip irrigation is the most suitable method of applying water for crop production. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock and red alder. The common understory plants are western swordfern, salal, Oregongrape, vine maple, western brackenfern, and trailing blackberry.

On the basis of a 100-year site curve, the mean site

index for Douglas fir is 146. On the basis of a 50-year site curve, it is 112. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 153 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and displacement.

Seedling establishment is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit is suited to homesite development. It has few limitations. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to compensate for this limitation.

This map unit is in capability subclass IIIe.

**101-Lynden-Urban land complex, 0 to 3 percent slopes.** This map unit is on terraces. The native vegetation is mainly conifers and shrubs. Elevation is 70 to 120 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 55 percent Lynden sandy loam and 35 percent Urban land. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Hale, Tromp, and Lynnwood soils and small areas of Lynden soils that have slopes of more than 3 percent. Included areas make up about 10 percent of the total acreage.

The Lynden soil is very deep and well drained. It formed in loess and volcanic ash over glacial outwash. Typically, the surface layer is dark brown sandy loam 8 inches thick. The subsoil is dark brown sandy loam 10 inches thick. The substratum is variegated sand. The upper 12 inches is dominantly very dark grayish brown, and the lower part to a depth of 60 inches is dominantly dark grayish brown. The depth to sand ranges from 14 to 24 inches. In some areas the surface layer is loam or loamy sand. In other areas the soil has 15 to 25 percent pebbles in the substratum. In some places the lower part of the subsoil, the substratum, or both are weakly cemented, mottled, or both. In other places the combined thickness of the surface layer and subsoil is 24 to 36 inches or 8 to 14 inches.

Permeability is moderately rapid in the upper part of the Lynden soil and very rapid in the lower part. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is very slow, and there is no hazard of erosion.

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

The Lynden soil is used for lawns, gardens, parks, or vacant lots. This unit is well suited to homesite development. It has few limitations. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to compensate for this limitation.

The Lynden soil is in capability subclass IIIs. The Urban land is in capability subclass VIIIs.

**102-Lynnwood sandy loam, 0 to 5 percent slopes.** This very deep, somewhat excessively drained soil is on eskers and kames. It formed in glaciofluvial deposits mixed with loess and volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 5 inches, the surface layer is dark brown sandy loam. The subsoil is dark yellowish brown loamy sand 14 inches thick. The substratum to a depth of 60

inches is variegated sand. In some areas the surface layer is loamy sand or loam. In other areas the soil has 15 to 25 percent pebbles in the substratum or is 14 to 24 inches deep to loamy sand or sand.

Included in this unit are small areas of Lynden, Tromp, Everett, and Hale soils and small areas of Lynnwood soils that have slopes of more than 5 percent. Included areas make up about 10 percent of the total acreage.

Permeability is rapid in the Lynnwood soil. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is very slow, and there is no hazard of erosion,

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

The main limitation in the areas used for hay and pasture is the moderate available water capacity. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common understory plants are western brackenfern, salal, western swordfern, trailing blackberry, and red huckleberry.

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, it is 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 159 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and displacement.

Seedling establishment is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available,

natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit has few limitations for homesite development. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to compensate for this limitation,

This map unit is in capability subclass IVs.

### **103-Lynnwood sandy loam, 5 to 20 percent slopes.**

This very deep, somewhat excessively drained soil is on eskers and kames. It formed in glaciofluvial deposits mixed with loess and volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 5 inches, the surface layer is dark brown sandy loam. The subsoil is dark yellowish brown loamy sand 14 inches thick. The substratum to a depth of 60 inches is variegated sand. In some areas the surface layer is loamy sand or loam. In other areas the soil has 15 to 25 percent pebbles in the substratum or is 14 to 24 inches deep to loamy sand or sand.

Included in this unit are small areas of Lynden, Tromp, Everett, and Hale soils and small areas of Lynnwood soils that have slopes of more than 20 percent or less than 5 percent. Most of the steeper soils are on side slopes. Included areas make up about 10 percent of the total acreage.

Permeability is rapid in the Lynnwood soil. Available water capacity is moderate. The effective rooting depth is 60 inches. In most areas, runoff is medium and the hazard of water erosion is moderate. In areas used as woodland, however, runoff is slow and the hazard of erosion is slight.

This unit is used mainly for hay and pasture, as woodland, or as a site for homes.

The main limitations in the areas used for hay and pasture are the moderate available water capacity and hazard of water erosion during periods of reestablishment.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common

understory plants are western brackenfern, salal, western swordfern, trailing blackberry, and red huckleberry.

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, it is 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 159 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and displacement.

Seedling establishment is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation affecting homesite development is the slope. In shallow excavations retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Effluent from absorption fields can surface in downslope areas and create a health hazard. Installing the absorption field in fill approved by the health district helps to compensate for this limitation. The slope affects the installation of septic tank absorption fields. The absorption lines should be installed on the contour.

This map unit is in capability subclass IVs.

#### **104 Montborne gravelly loam, 5 to 30 percent slopes.**

This moderately deep, moderately well drained soil is on mountain back slopes and plateaus. It formed in an admixture of volcanic ash, loess, colluvium, and slope alluvium over glacial till derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 1,300 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 period is about 120 days.

Typically, the surface is covered with a mat of needles and twigs 4 inches thick. When mixed to a depth of 7 inches, the surface layer is dark yellowish brown gravelly loam. The subsoil is dark yellowish brown very gravelly loam 8 inches thick. The substratum is olive brown extremely gravelly sandy loam 18 inches thick. Dense glacial till that crushes to very gravelly loam is at a depth of 33 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil is 40 to 60 inches deep to phyllite till or bedrock or has less than 35 percent rock fragments in the subsoil.

Included in this unit are small areas of Rinker and Sorensen soils, soils that are shallow to dense glacial till, and Montborne soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Montborne soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from December through 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. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are vine maple, western brackenfern, western swordfern, trailing blackberry, red huckleberry, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index for western hemlock is 147. On the basis of a 50-year site curve, it is 105. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 232 cubic feet per acre per year, occurring at age 50. On the basis of a 100-year site curve, the mean site index for Douglas fir is 146. On the basis of a 50-year site curve, it is 114. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 153 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are occasional snowpack and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from January through March. Because most of

the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, Douglas fir, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass IVe.

**105-Montborne gravelly loam, 30 to 60 percent slopes.** This moderately deep, moderately well drained soil is on mountain back slopes and plateaus. It formed in an admixture of volcanic ash, loess, colluvium, and slope alluvium over glacial till derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 1,300 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 period is about 120 days.

Typically, the surface is covered with a mat of needles and twigs 4 inches thick. When mixed to a depth of 7 inches, the surface layer is dark yellowish brown gravelly loam. The subsoil is dark yellowish brown very gravelly loam 8 inches thick. The substratum is olive brown extremely gravelly sandy loam 18 inches thick. Dense glacial till that crushes to

very gravelly loam is at a depth of 33 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil is 40 to 60 inches deep to phyllite till or bedrock or has less than 35 percent rock fragments in the subsoil.

Included in this unit are small areas of Rinker and Sorensen soils, soils that are shallow to dense glacial till, and Montborne soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Montborne soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from December through 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. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are vine maple, western brackenfern, western swordfern, trailing blackberry, red huckleberry, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index for western hemlock is 147. On the basis of a 50-year site curve, it is 105. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 232 cubic feet per acre per year, occurring at age 50. On the basis of a 100-year site curve, the mean site index for Douglas fir is 146. On the basis of a 50-year site curve, it is 114. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 153 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface. Cut and fill slopes tend

to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, Douglas fir, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**106-Montborne-Rinker complex, 30 to 60 percent slopes.** This map unit is on mountain back slopes. The native vegetation is mainly conifers and shrubs. Elevation is 1,300 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 period is about 120 days.

This unit is 60 percent Montborne gravelly loam and 25 percent Rinker very channery silt loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Sorensen soils, soils that are less than 20 inches deep to dense glacial till or phyllite, Rock outcrop, stony areas, and Montborne and Rinker soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

The Montborne soil is moderately deep and moderately well drained. It formed in an admixture of volcanic ash, loess, colluvium, and slope alluvium over glacial till derived dominantly from phyllite. Typically, the

surface is covered with a mat of needles and twigs 4 inches thick. When mixed to a depth of 5 inches, the surface layer is dark brown gravelly loam. The subsoil is dark yellowish brown very gravelly loam 15 inches thick. The substratum is olive brown very gravelly silt loam 8 inches thick. Dense glacial till that crushes to very gravelly loam is at a depth of 28 inches. The depth to dense glacial till ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam or very gravelly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil.

Permeability is moderate in the upper part of the Montborne soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from December through April. Runoff is medium, and the hazard of water erosion is moderate.

The Rinker soil is moderately deep and well drained. It formed in a mixture of volcanic ash, colluvium, and slope alluvium derived dominantly from phyllite. Typically, the surface is covered with a mat of needles and twigs 2 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown very channery silt loam. The subsoil is dark yellowish brown very channery silt loam 4 inches thick. The substratum is olive brown extremely channery loam 19 inches thick. It is underlain by phyllite at a depth of about 30 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is channery silt loam or very channery loam. In other areas the soil is 40 to 60 inches deep to phyllite.

Permeability is moderate in the Rinker soil. Available water capacity is high. The 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. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are vine maple, western brackenfern, western swordfern, trailing blackberry, red huckleberry, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index for western hemlock on the Montborne soil is 147. On the basis of a 50-year site curve, it is 105. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 232 cubic feet per acre per year, occurring at age 50. On the basis of a 100-year site curve, the mean site index for Douglas fir is 146. On the basis of a 50-year site curve, it is 114. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 153 cubic feet per acre per year, occurring at age 60.

On the basis of a 100-year site curve, the mean site index for western hemlock on the Rinker soil is 157. On the basis of a 50-year site curve, it is 110. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 249 cubic feet per acre per year, occurring at age 50. On the basis of a 100-year site curve, the mean site index for Douglas fir is 146. On the basis of a 50-year site curve, it is 107. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 153 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Phyllite, a poor-quality rock for road construction, is readily available. Extra rock is needed to maintain a stable, uniform road surface. Cut and fill slopes tend to slump when wet. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of compaction when the soils are moist and a high degree of puddling when the soils are wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock, Douglas fir, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting

depth is restricted by the dense glacial till or the bedrock, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

The Montborne and Rinker soils are in capability subclass VIIe.

**107-Mt. Vernon fine sandy loam, 0 to 2 percent slopes.** This very deep, moderately well drained soil is on river terraces and on flood plains. It formed in alluvium with an admixture of volcanic ash. The native vegetation is mainly conifers and shrubs. Elevation is 10 to 100 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the upper part of the surface layer is dark brown fine sandy loam 7 inches thick. The lower part is very dark grayish brown fine sandy loam 6 inches thick. The underlying material to a depth of 60 inches is dark grayish brown, olive brown, olive gray, and dark gray, mottled, stratified fine sandy loam, very fine sandy loam, and sand. In some areas the surface layer is very fine sandy loam. In other areas the soil is fine sandy loam in the underlying material, has sand at a depth of 40 to 60 inches, or has less than 50 percent base saturation in the surface layer.

Included in this unit are small areas of Briscot, Puyallup, Eliza, and Oridia soils, Shalcar soils in depressions, Riverwash, and Mt. Vernon soils that have slopes of more than 2 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Mt. Vernon soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 2 to 4 feet from November through April. Runoff is very slow, and there is no hazard of erosion. In most areas this soil is subject to occasional, brief periods of flooding from November through April. Downstream from Lynden, however, it is subject to frequent, brief periods of flooding from December through February.

This unit is used mainly for hay and pasture or as cropland. It also is used as woodland and as a site for homes.

The main limitations in the areas used for hay and pasture are the seasonal high water table and the hazard of flooding. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition.

The main limitation in the areas used as cropland is the seasonal high water table. This unit is suited to all crops commonly grown in the survey area. The principal crops are peas, sweet corn, beans, small grain, raspberries, carrots, and corn silage. In summer,

irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common understory plants are western swordfern, western brackenfern, trailing blackberry, Oregongrape, salal, vine maple, and salmonberry.

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, it is estimated to be 130. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 185 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the hazard of flooding and the muddiness caused by seasonal wetness. These limit the use of equipment to dry periods. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and displacement.

Seedling establishment is the main concern affecting timber production. The occasional flooding hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitations affecting homesite development are the hazard of flooding and the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitations on sites for septic tank absorption fields are the hazard of flooding and the seasonal wetness. Installing the

absorption field in fill approved by the health district helps to compensate for the wetness. Dikes and channels that have outlets to bypass floodwater can be used to protect buildings and onsite sewage disposal systems from flooding.

This map unit is in capability subclass IIw.

**108-Nati loam, 5 to 15 percent slopes.** This moderately deep, well drained soil is on foothill back slopes and toe slopes. It formed in colluvium and slope alluvium with an admixture of volcanic ash and glacial till. The colluvium and alluvium are derived from sandstone and siltstone. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 1,600 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown loam 3 inches thick. The upper 7 inches of the subsoil is dark brown loam. The lower 27 inches is dark yellowish brown loam. Sandstone is at a depth of about 37 inches. The depth to sandstone or siltstone ranges from 20 to 40 inches. In some areas the surface layer is sandy loam or silt loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Squalicum, Sehome, Chuckanut, and Comar soils; Bellingham and Shalcar soils in depressions; and Nati soils that have slopes of more than 15 percent or less than 5 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Nati soil. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture and as a site for homes. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are red huckleberry, salal, Oregongrape, western swordfern, and western brackenfern.

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, it is 121. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 169 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting

during rainy periods. Logging roads require suitable surfacing for year-round use. Sandstone, a poor-quality rock for road construction, is readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitation in the areas used for hay and pasture is the hazard of erosion during periods of reestablishment. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition.

The main limitations affecting homesite development are the depth to bedrock and the slope. The deep cuts needed to provide essentially level building sites can expose bedrock. The main limitation on sites for septic tank absorption fields is the depth to bedrock. This limitation can be overcome by installing the absorption field at a shallow depth and by installing absorption lines that are longer than normal and that are on the contour. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope.

This map unit is in capability subclass IVs.

**109-Nati loam, 15 to 30 percent slopes.** This moderately deep, well drained soil is on foothill back slopes and toe slopes. It formed in colluvium and slope alluvium with an admixture of volcanic ash and glacial till. The colluvium and alluvium are derived from sandstone and siltstone. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 1,600 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. The surface

layer is dark brown loam 8 inches thick. The upper 8 inches of the subsoil is dark yellowish brown loam. The lower 15 inches is brownish yellow fine sandy loam. Sandstone is at a depth of about 31 inches. The depth to sandstone or siltstone ranges from 20 to 40 inches. In some areas the surface layer is sandy loam or silt loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Squalicum, Sehome, Chuckanut, and Comar soils; Bellingham and Shalcar soils in depressions; and Nati soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Nati soil. Available water capacity also is moderate. The 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. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are red huckleberry, salal, Oregon grape, western swordfern, and western brackenfern.

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, it is 121. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 169 cubic feet per acre per year, occurring at age 65.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be

accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass IVe.

**110-Nati loam, 30 to 60 percent slopes.** This moderately deep, well drained soil is on foothill back slopes and ridges. It formed in colluvium and slope alluvium with an admixture of volcanic ash and glacial till. The colluvium and alluvium are derived from sandstone and siltstone. The native vegetation is mainly conifers and shrubs. Elevation is 100 to 1,600 feet. The average annual precipitation is about 40 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles and twigs 1 inch thick. The surface layer is dark brown loam 10 inches thick. The subsoil is dark yellowish brown loam 28 inches thick. Sandstone is at a depth of about 38 inches. The depth to sandstone or siltstone ranges from 20 to 40 inches. In some areas the surface layer is sandy loam or silt loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Squalicum, Sehome, Chuckanut, and Comar soils; Bellingham and Shalcar soils in depressions; Rock outcrop; and Nati soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Nati soil. Available water capacity also is moderate. The 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. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are red huckleberry, salal, Oregongrape, western swordfern, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 129. On the basis of a 50-year site curve, it is 98. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 128 cubic feet per acre per year, occurring at age 70. Areas on ridgetops that are subject to strong, persistent winds

are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**111-Neptune very gravelly sandy loam, 0 to 3 percent slopes.** This very deep, somewhat excessively drained soil is on marine ridges, spits, and terraces. In many areas it is below escarpments. It formed in coastal beach deposits that contain marine shells. The native vegetation is mainly conifers and shrubs. Elevation is 5 to 20 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is black very gravelly sandy loam 10 inches thick. The upper 17 inches of the underlying material is very dark brown extremely

gravelly loamy sand. The lower part to a depth of 60 inches is variegated extremely gravelly sand or extremely gravelly coarse sand. In some areas the surface layer is very gravelly loam or gravelly sandy loam. In other areas the soil has a partially cemented substratum.

Included in this unit are small areas of Hovde soils, deposits of sand, and bodies of water. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the Neptune soil. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is very slow, and there is no hazard of erosion. The soil is subject to rare flooding from tidal inundation.

This unit is used as woodland or as a site for homes and industry. It also is used for recreation.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder and bigleaf maple. The common understory plants are salal, Oregongrape, western swordfern, and vine maple.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 132. On the basis of a 50-year site curve, it is estimated to be 100. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 133 cubic feet per acre per year, occurring at age 70.

The kind of equipment that can be used and the time of the year when it can be used normally are not restricted on this unit. Generally, the surface layer is loose when dry. As a result, the use of wheeled and tracked equipment is limited. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement.

Seedling mortality is the main concern affecting timber production. A high soil temperature and a low content of moisture in the soil during the growing season cause a high rate of seedling mortality. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation affecting homesite development

is the hazard of flooding. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity. Installing the absorption field in fill approved by the health district helps to compensate for this limitation.

This map unit is in capability subclass IVs.

**112-Oakes very gravelly loam, 8 to 30 percent slopes.** This very deep, well drained soil is on colluvial side slopes on mountains. It formed in volcanic ash, colluvium, and slope alluvium derived from glacial drift. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 2,500 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F, and the average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown very gravelly loam 4 inches thick. The upper 12 inches of the subsoil is dark brown very gravelly loam. The lower 8 inches is dark brown extremely gravelly sandy loam. The substratum to a depth of 60 inches is olive brown extremely cobbly fine sandy loam. In some areas the surface layer is very gravelly sandy loam or gravelly loam. In other areas the soil has a substratum of loamy sand, is 40 to 60 inches deep to dense glacial till or bedrock, is moderately well drained, or has 15 to 35 percent total rock fragments or more than 15 percent phyllite rock fragments in the solum or substratum.

Included in this unit are small areas of Cupples, Sorensen, Montborne, Rinker, and Welcome soils, stony areas, slump areas, and Oakes soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Oakes soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are salal, Oregongrape, western swordfern, western brackenfern, red huckleberry, vine maple, trailing blackberry, and tall blue huckleberry.

On the basis of a 100-year site curve, the mean site index is 152 for Douglas fir and 148 for western hemlock. On the basis of a 50-year site curve, it is 117 for Douglas fir and 105 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 161 cubic feet per acre per

year, occurring at age 60. For western hemlock, it is 234 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, the snowpack limits the use of equipment and restricts access from January through March. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVe.

**113-Oakes very gravelly loam, 30 to 60 percent slopes.** This very deep, well drained soil is on colluvial side slopes on mountains. It formed in volcanic ash, colluvium, and slope alluvium derived from glacial drift. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 2,500 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F, and the average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown very gravelly loam 5 inches thick. The upper 12 inches of the subsoil is dark brown very gravelly loam. The lower 12 inches is dark brown extremely gravelly sandy loam. The substratum to a depth of 60 inches is olive brown extremely cobbly fine sandy loam. In some areas the surface layer is very gravelly sandy loam or gravelly loam. In other areas the soil has a substratum of loamy sand, is 40 to 60 inches deep to dense glacial till or bedrock, is moderately well drained, or has 15 to 35 percent total rock fragments or more than 15 percent phyllite rock fragments in the solum or substratum.

Included in this unit are small areas of Cupples, Sorensen, Montborne, Rinker, and Welcome soils, stony areas, slump areas, and Oakes soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Oakes soil. Available water capacity is high. The effective rooting depth is 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. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are salal, Oregon grape, western swordfern, western brackenfern, red huckleberry, vine maple, trailing blackberry, and tall blue huckleberry.

On the basis of a 100-year site curve, the mean site index is 152 for Douglas fir and 148 for western hemlock. On the basis of a 50-year site curve, it is 117 for Douglas fir and 105 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 161 cubic feet per acre per year, occurring at age 60. For western hemlock, it is 234 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher

on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

**114-Oakes very gravelly loam, 60 to 80 percent slopes.** This very deep, well drained soil is on colluvial side slopes and canyon sides on mountains. It formed in volcanic ash, colluvium, and slope alluvium derived from glacial drift. The native vegetation is mainly conifers and shrubs. Elevation is 1,500 to 2,500 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 44 degrees F, and the average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. When mixed to a depth of 8 inches, the surface layer is dark brown very gravelly loam. The upper 10 inches of the subsoil is dark brown very gravelly sandy loam. The lower 16 inches is dark brown extremely gravelly sandy loam. The substratum to a depth of 60 inches is dark grayish brown extremely gravelly sandy loam. In some areas the surface layer is very gravelly sandy loam. In other areas the soil has an extremely cobbly or extremely stony substratum, is 40 to 60 inches deep to dense glacial till or bedrock, is moderately well drained, or has 15 to 35 percent total rock fragments in the solum or substratum.

Included in this unit are small areas of Cupples, Sorensen, Montborne, and Welcome soils, stony areas, Rock outcrop, and Oakes soils that have slopes of less than 60 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Oakes soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are salal, Oregongrape, western swordfern, western brackenfern, red huckleberry, vine maple, trailing blackberry, and tall blue huckleberry.

On the basis of a 100-year site curve, the mean site index is 127 for Douglas fir and is estimated to be 140 for western hemlock. On the basis of a 50-year site curve, it is 94 for Douglas fir and is estimated to be 100 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 125 cubic feet per acre per year, occurring at age 70. For western hemlock, it is about 218 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. These systems generally are used on this unit. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production.

Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir, western hemlock, or red alder seedlings. Because of the slope, planting seedlings is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir and red alder occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

**115-Oridia silt loam, drained, 0 to 2 percent slopes.**

This very deep, poorly drained soil is on flood plains. It has been artificially drained. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is 20 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark grayish brown silt loam 10 inches thick. The upper 22 inches of the underlying material is dark grayish brown, mottled silt loam and very fine sandy loam. The lower part to a depth of 60 inches is gray and grayish brown, mottled very fine sandy loam. In some areas the surface layer is very fine sandy loam. In other areas the soil has a dark brown surface layer, is sandy loam or loam in the lower part of the underlying material, has thin strata of sand, or has 18 to 25 percent clay in the upper part of the underlying material.

Included in this unit are small areas of Shalcar soils, which are in depressions and are subject to ponding, and small areas of Mt. Vernon soils and undrained Oridia soils. Also included are small bodies of water. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the Oridia soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 3 feet from November through April. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion. In most areas this soil is subject to occasional, brief periods of flooding from November through April. Downstream from Lynden, however, it is subject to frequent, brief periods of flooding from December through February.

This unit is used mainly for hay and pasture or as cropland. The included undrained Oridia soils are used as woodland.

The main limitations in the areas used for hay and pasture are the high water table and the hazard of flooding. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. In areas where the drainage system is not maintained or in areas that do not have drainage, the water table limits the use of this unit to grasses and shallow-rooted legumes. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

The main limitations in the areas used as cropland are the high water table and the hazard of flooding. This soil is well suited to most-crops commonly grown in the

survey area if adequate drainage systems are maintained. These crops are peas, sweet corn, beans, and small grain. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping sequence help to maintain fertility and tilth. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Tile drains and field ditches should be maintained. They permit fieldwork to be conducted earlier in the spring and increase the yields of perennial crops. In summer, irrigation is required for maximum production.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar and black cottonwood. The common understory plants are salmonberry, Douglas spirea, rose, stinging nettle, and sedges.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the occasional flooding and the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of, compaction and puddling.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. The high water table and the flooding hinder root respiration and thus result in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitations are the high water table and the hazard

of flooding. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the seasonal high water table and the hazard of flooding. The seasonal high water table increases the likelihood that the absorption field will fail. Installing absorption lines that are longer than normal helps to overcome this limitation.

This map unit is in capability subclass IIw.

**116-Pangborn muck, drained, 0 to 2 percent slopes.**

This very deep, very poorly drained soil is in depressions on outwash terraces and on some till plains and stream terraces. It has been artificially drained. It formed in herbaceous and woody organic deposits. The native vegetation is mainly shrubs, forbs, and trees. Elevation is near sea level to 600 feet above sea level. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark reddish brown muck 15 inches thick. The underlying material to a depth of 60 inches is very dark brown and dark reddish brown muck. In some areas the soil is hemic material.

Included in this unit are small areas of Shalcar, Bellingham, Snohomish, Puget, Fishtrap, and Hale soils, ponded areas, and Pangborn soils that have not been drained or have slopes of more than 2 percent. Included areas make up about 10 percent of the total acreage..

Permeability is moderate in the Pangborn soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 2.5 feet from October through May. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion.

This unit is used mainly for hay and pasture or as cropland (fig. 5). The included undrained Pangborn soils are used as woodland.

The main limitation in the areas used for hay and pasture is the high water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

The main limitations in the areas used as cropland are the high water table and the soil acidity. This soil is well suited to most crops commonly grown in the survey area if adequate drainage systems are maintained. The principal crops are potatoes, blueberries, and corn silage. Tile drains and field ditches should be

maintained. They permit fieldwork to be conducted earlier in the spring and increase the yields. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Subsidence is minimized if the water table is maintained directly below the root zone during the growing season and then allowed to return to the surface during the winter. Using regulating structures in open ditches as a means of subirrigation reduces the extent of subsidence. In summer, irrigation is required for maximum production. Soil acidity can be reduced by adding lime.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, lodgepole pine, and Sitka spruce. The common understory plants are willow, Douglas spirea, salmonberry, stinging nettle, and sedges.

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 in unmanaged, even-aged stands of red alder is about 92 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The high water table limits the use of equipment to dry periods. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. The high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitations are the high water table and the low strength. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. If buildings are



Figure 5.-Open ditch drainage in a pastured area of Pangborn muck, drained, 0 to 2 percent slopes.

constructed on this soil, the muck should be excavated or the buildings should be constructed on piles anchored in the mineral soil. The design of buildings and roads can offset the limited ability of the soil to support a load. The high water table is a limitation on sites for septic tank absorption fields. Installing the absorption field in fill approved by the health district helps to compensate for this limitation.

This map unit is in capability subclass IIw.

**117-Pickett-Rock outcrop complex, 5 to 30 percent slopes.** This map unit is on glacially modified foot slopes, back slopes, and ridgetops. The native vegetation is mainly conifers and shrubs. Elevation is sea level to 1,700 feet above sea level. The average annual precipitation is about 35 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 180 days.

This unit is 65 percent Pickett very gravelly silt loam

and 20 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Everett, Kickerville, Nati, and Squalicum soils, soils that are less than 20 inches deep over bedrock, stony areas, poorly drained mineral soils in depressions, and Pickett soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

The Pickett soil is moderately deep and well drained. It formed in colluvium derived from graywacke and argillite with an admixture of volcanic ash. Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 7 inches, the surface layer is dark brown very gravelly silt loam. The subsoil is dark brown very gravelly silt loam 16 inches thick. Argillite is at a depth of about 23 inches. The depth to argillite or graywacke ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Pickett soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

Typically, the Rock outcrop is argillite or graywacke. It is hard and generally unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, and western redcedar. The common understory plants are Oregon grape, salal, western swordfern, creambush oceanspray, and red huckleberry.

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, it is estimated to be 88. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 106 cubic feet per acre per year, occurring at age 60. Yields are reduced by the extent of the Rock outcrop. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is the Rock outcrop. The pattern of the Rock outcrop on the landscape results in a discontinuous slope, which hinders the use of cable yarding systems. The trees can break if they are felled on the Rock outcrop. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction

is readily available. Cut and fill slopes tend to slump when wet.

Seedling establishment is the main concern affecting timber production. A high soil temperature and a low content of moisture in the soil during the growing season cause a high rate of seedling mortality. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the Pickett soil is wet and winds are strong.

The Pickett soil is in capability subclass IVe. The Rock outcrop is in capability subclass VIIIs.

**118-Pickett-Rock outcrop complex, 30 to 60 percent slopes.** This map unit is on glacially modified foot slopes, back slopes, and ridgetops. The native vegetation is mainly conifers and shrubs. Elevation is sea level to 1,700 feet above sea level. The average annual precipitation is about 35 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 180 days.

This unit is 60 percent Pickett very gravelly silt loam and 25 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Nat! and Sehome soils, soils that are less than 20 inches deep over bedrock, stony areas, poorly drained mineral soils in depressions, and Pickett soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

The Pickett soil is moderately deep and well drained. It formed in colluvium derived from graywacke and argillite with an admixture of volcanic ash. Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown very gravelly silt loam. The subsoil is brown very gravelly silt loam 22 inches thick. Graywacke is at a depth of about 29 inches. The depth to argillite or graywacke ranges from 20 to 40 inches. In some areas the surface layer is gravelly silt loam. In other areas the soil is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Pickett soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

Typically, the Rock outcrop is argillite or graywacke. It is hard and generally unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, and western redcedar. The common understory plants are Oregongrape, salal, western swordfern, creambush oceanspray, and red huckleberry.

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, it is estimated to be 88. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 106 cubic feet per acre per year, occurring at age 60. Yields are reduced by the extent of the Rock outcrop. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, the Rock outcrop, and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. The pattern of the Rock outcrop on the landscape results in a discontinuous slope, which hinders the use of cable yarding systems. The trees can break if they are felled on the Rock outcrop. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the underlying soil. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless adequate water bars are provided, or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. A high soil temperature and a low content of moisture in the soil during the growing season cause a high rate of seedling mortality. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by

planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the Pickett soil is wet and winds are strong.

The Pickett soil is in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

#### **119-Pilchuck loamy fine sand, 0 to 3 percent slopes.**

This very deep, somewhat excessively drained soil is on flood plains. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is 50 to 400 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 6 inches, the surface layer is black loamy fine sand. The upper 38 inches of the underlying material is very dark grayish brown, dark brown, and very dark brown fine sand and loamy fine sand. The lower part to a depth of 60 inches is black sand. In some areas the surface layer is loamy sand, sand, or sandy loam. In other areas the soil has a gravelly substratum or has a substratum with strata of sandy loam.

Included in this unit are small areas of Puyallup and Snoqualmie soils, small areas of organic soils and Briscot soils in depressions, Riverwash, and soils that are similar to the Pilchuck soil but have a seasonal high water table at a depth of 48 to 60 inches. Included areas make up about 10 percent of the total acreage.

Permeability is rapid in the Pilchuck soil. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is very slow, and the hazard of water erosion is severe because of flooding and channeling. A seasonal high water table fluctuates in depth from 2 to 4 feet from November through April. This soil is subject to frequent, brief periods of flooding from November through April during periods of snowmelt and rainfall.

This unit is used mainly as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, bigleaf maple, and black cottonwood. The common understory plants are vine maple, western swordfern, salmonberry, common snowberry, false Solomons seal, and western brackenfern.

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, it is estimated to be 114. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 161 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the flooding. This limits the use of equipment to dry periods. Generally, the surface layer is loose when dry. As a result, the use of wheeled and tracked equipment is limited. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface can easily result in soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. A reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and establishment are the main concerns affecting timber production. The seedling survival rate is reduced by droughtiness in the surface layer and may be low in areas where flooding occurs. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder, bigleaf maple, and black cottonwood occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVw.

**120-Pits, gravel.** This map unit is on glaciomarine drift plains, outwash terraces, mountains, and foothills. It consists of areas excavated for gravel, sand, and hard rock. Areas are irregular in shape and are 5 to 90 acres in size.

Included in this unit are small areas of soils that have not been excavated, areas that have been partially filled as dump sites, areas that have no gravel or hard rock, and small ponds where material has been excavated below the water table.

A seasonal high water table fluctuates in depth from 0 to more than 60 inches from November through April. Permeability, the effective rooting depth, available water capacity, surface runoff, and the hazard of erosion vary widely. They are dependent on the amount of disturbance of the soil. Runoff is ponded to very rapid, and the hazard of water erosion ranges from none to severe.

This unit is used mainly for excavation of gravel or

rock deposits. It also is used for wildlife habitat. This unit varies too much to be rated for potential uses. Onsite evaluation is needed. The main limitation in areas used as woodland, pasture, or cropland is a lack of soil fertility.

This map unit is in capability subclass VIIIs.

**121-Potchub loam, 8 to 30 percent slopes.** This moderately deep, moderately well drained soil is on high mountain back slopes and ridges. It formed in an admixture of volcanic ash, loess, and colluvium over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 10 inches thick. When mixed to a depth of 7 inches, the surface layer is loam. The upper 8 inches of the subsoil is organic stained, strong brown loam. The lower 17 inches is strong brown and yellowish red gravelly loam. Dense glacial till that crushes to extremely gravelly loam is at a depth of 32 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is silt loam or gravelly loam. In other areas the soil has a very gravelly subsoil, has a less developed subsoil, is 40 to 60 inches deep to dense glacial till or bedrock, or has less than 6 percent organic carbon in the upper part of the subsoil.

Included in this unit are small areas of Kulshan, Hartnit, Clendenen, and Gallup soils, soils that are similar to the Potchub soil but are underlain by soft sandstone at a depth of 20 to 40 inches, poorly drained mineral and organic soils in depressions, and Potchub soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Potchub soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through May. 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. Among the trees of limited extent are mountain hemlock and western redcedar. The common understory plants are red huckleberry, blueleaved huckleberry, bunchberry dogwood, deer fern, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index for western hemlock is 101. On the basis of a 50-

year site curve, it is 72. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 144 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

**122-Potchub loam, 30 to 60 percent slopes.** This moderately deep, moderately well drained soil is on high mountain back slopes and ridges. It formed in an admixture of volcanic ash, loess, and colluvium over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average

annual precipitation is about 90 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 8 inches thick. When mixed to a depth of 7 inches, the surface layer is strong brown loam. The upper 22 inches of the subsoil is strong brown gravelly loam and gravelly sandy loam. The lower 10 inches is brown gravelly sandy loam. Dense glacial till is at a depth of about 39 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is silt loam or gravelly loam. In other areas the soil has a very gravelly subsoil, has a less developed subsoil, is 40 to 60 inches deep to dense glacial till or bedrock, or has less than 6 percent organic carbon in the upper part of the subsoil.

Included in this unit are small areas of Kulshan, Hartnit, Clendenen, and Gallup soils, soils that are similar to the Potchub soil but are underlain by soft sandstone at a depth of 20 to 40 inches, Rock outcrop, and Potchub soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Potchub soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through May. 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. Among the trees of limited extent are mountain hemlock and western redcedar. The common understory plants are red huckleberry, blueleaved huckleberry, bunchberry dogwood, deer fern, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index for western hemlock is 101. On the basis of a 50-year site curve, it is 72. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 144 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are

concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock, mountain hemlock, and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

### **123-Puget silt loam, drained, 0 to 2 percent slopes.**

This very deep, poorly drained soil is on flood plains. It has been artificially drained. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is 20 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark grayish brown, mottled silt loam 9 inches thick. The upper 7 inches of the underlying material is grayish brown, mottled silt loam. The lower part to a depth of 60 inches is gray and dark gray, mottled silt loam. In some areas the surface layer is silty clay loam. In other areas the soil has a dark brown surface layer; is not mottled in the surface layer; is sandy loam, loamy sand, or sand in the lower part of the underlying material; has 10 to 18 percent clay in the upper part of the underlying material;

or has thin strata of sandy material in the underlying material.

Included in this unit are small areas of Shalcar soils, which are in depressions and are subject to ponding, and small areas of Mt. Vernon soils and undrained Puget soils. Also included are small bodies of water. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Puget soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 3 feet from November through May. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion. In most areas this soil is subject to occasional, brief periods of flooding from November through April. Downstream from Lynden, however, it is subject to frequent, brief periods of flooding from December through February.

This unit is used mainly for hay and pasture or as cropland. The included undrained Puget soils are used as woodland.

The main limitations in the areas used for hay and pasture are the high water table, the hazard of flooding, and the moderately slow permeability. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. In areas where the drainage system is not maintained or in areas that do not have drainage, the water table limits the use of this unit to grasses. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

The main limitations in the areas used as cropland are the high water table, the hazard of flooding, and the moderately slow permeability. This soil is well suited to most crops commonly grown in the survey area if adequate drainage systems are maintained. These crops are peas, sweet corn, beans, and small grain. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping sequence help to maintain fertility and tilth. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Tile drains and field ditches should be maintained. They permit fieldwork to be conducted earlier in the spring and increase the yields of perennial crops. Drainage tiles should be closely spaced because of the moderately slow permeability. In summer, irrigation is required for maximum production.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar and black cottonwood. The common understory plants are

salmonberry, Douglas spirea, rose, stinging nettle, and sedges.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the occasional flooding and the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. The high water table and the flooding hinder root respiration and thus result in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitations are the high water table and the hazard of flooding. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the restricted permeability, the high water table, and the hazard of flooding. Installing absorption lines that are longer than normal helps to overcome these limitations.

This map unit is in capability subclass IIw.

#### **124-Puyallup fine sandy loam, 0 to 2 percent slopes.**

This very deep, well drained soil is on low river terraces and on flood plains. It formed in alluvium. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual

precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 180 days.

Typically, the upper part of the surface layer is very dark grayish brown fine sandy loam 6 inches thick. The lower part is very dark grayish brown loam and fine sandy loam 13 inches thick. The underlying material to a depth of 60 inches is very dark grayish brown sand. The depth to loamy sand or sand ranges from 15 to 30 inches. In some areas the surface layer is loam or silt loam. In other areas the soil has less than 50 percent base saturation in the surface layer, has a substratum stratified with sandy loam, or has a gravelly substratum.

Included in this unit are small areas of Briscot, Oridia, Mt. Vernon, and Pilchuck soils; small areas of Bellingham, Shalcar, and Fishtrap soils in depressions; Riverwash; and Puyallup soils that have slopes of more than 2 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Puyallup soil and rapid in the lower part. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is very slow, and there is no hazard of erosion. In most areas this soil is subject to occasional, brief periods of flooding from November through April. Downstream from Lynden, however, it is subject to frequent, brief periods of flooding from December through February. Channeling and deposition are common along streambanks.

This unit is used mainly for hay and pasture or as cropland. It also is used as woodland and as a site for homes.

The main limitation in the areas used for hay and pasture are the moderate available water capacity and the hazard of flooding. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. In summer, irrigation is required for maximum production.

The main limitations in the areas used as cropland are the moderate available water capacity and the hazard of flooding. This unit is suited to all crops commonly grown in the survey area. The principal crops are peas, sweet corn, beans, small grain, raspberries, carrots, and corn silage. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, bigleaf maple, black cottonwood, and western hemlock. The common understory plants are trailing blackberry, salmonberry, Oregongrape, western swordfern, vine maple, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 167. On the basis of a 50-year site curve, it is 125. The highest average growth rate in

unmanaged, even-aged stands of Douglas fir is 178 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the hazard of flooding and the muddiness caused by seasonal wetness. These limit the use of equipment to dry periods. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and displacement.

Seedling establishment is the main concern affecting timber production. The occasional flooding hinders root respiration and thus results in a low seedling survival rate. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation affecting homesite development is the hazard of flooding. The main limitations on sites for septic tank absorption fields are a poor filtering capacity in the substratum and the hazard of flooding. Septic tank-absorption fields may not function properly during rainy periods because of the wetness. Installing the absorption field in fill approved by the health district helps to overcome these limitations.

This map unit is in capability subclass IIw.

**125-Revel loam, 5 to 30 percent slopes.** This moderately deep, well drained soil is on mountain back slopes, ridges, and plateaus. It formed in a mixture of volcanic ash, glacial till, colluvium, and slope alluvium derived dominantly from sandstone and siltstone. The native vegetation is mainly conifers and shrubs. Elevation is 1,200 to 2,200 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 45 degrees F, and the average

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 10 inches, the surface layer is dark brown loam. The subsoil is dark yellowish brown loam 9 inches thick. The upper 12 inches of the substratum is light olive brown sandy loam. The lower part is light yellowish brown sandy loam 8 inches thick. Sandstone is at a depth of about 39 inches. The depth to sandstone or siltstone ranges from 20 to 40 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is sandy loam. In other areas the soil has a gravelly substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Dekapen, Oakes, and Squalicum soils, stony areas, slump areas, poorly drained soils in depressions, soils that are less than 20 inches deep to sandstone, and Revel soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Revel soil. Available water capacity also is moderate. The 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. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common understory plants are Oregon grape, red huckleberry, western swordfern, salal, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 121. On the basis of a 50-year site curve, it is 91. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 116 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are occasional snowpack and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from January through March. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Sandstone, a poor-quality rock for road construction, is readily available. Cut and

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass IVe.

**126-Revel loam, 30 to 60 percent slopes.** This moderately deep, well drained soil is on mountain back slopes, ridges, and plateaus. It formed in a mixture of volcanic ash, glacial till, colluvium, and slope alluvium derived dominantly from sandstone and siltstone. The native vegetation is mainly conifers and shrubs. Elevation is 1,200 to 2,200 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 45 degrees F, and the average frost-free period is about 135 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown loam 4 inches thick. The subsoil is dark brown loam 12 inches thick. The substratum is dark yellowish brown sandy loam 19 inches thick. Sandstone is at a depth of about 35 inches. The depth to sandstone or siltstone ranges from 20 to 40 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is sandy loam. In other areas the soil has a gravelly substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Dekapen, Oakes, and Squalicum soils, Rock outcrop, stony areas, slump areas, poorly drained soils in depressions, soils that are less than 20 inches deep to sandstone, and Revel soils that have slopes of more than 60 percent or

less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Revel soil. Available water capacity also is moderate. The 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. Among the trees of limited extent are western hemlock, western redcedar, and red alder. The common understory plants are Oregongrape, red huckleberry, western swordfern, salal, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 121. On the basis of a 50-year site curve, it is 91. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 116 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Cut and fill slopes tend to slump when wet. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover

areas by western hemlock and Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**127-Revel-Welcome-Rock outcrop complex, 30 to 60 percent slopes.** This map unit is on mountain slopes and ridges. The native vegetation is mainly conifers and shrubs. Elevation is 1,500 to 2,200 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 45 degrees F, and the average frost-free period is about 130 days.

This unit is 45 percent Revel loam, 30 percent Welcome loam, and 10 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Dekapen, Oakes, and Squalicum soils, stony areas, slump areas, soils that are less than 20 inches deep to sandstone, and Revel and Welcome soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

The Revel soil is moderately deep and well drained. It formed in a mixture of volcanic ash, glacial till, colluvium, and slope alluvium derived dominantly from sandstone. Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. The surface layer is dark brown loam 4 inches thick. The subsoil is dark brown loam 12 inches thick. The substratum is dark yellowish brown sandy loam 19 inches thick. It is underlain by sandstone at a depth of about 35 inches. The depth to sandstone ranges from 20 to 40 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is sandy loam. In other areas the soil has a gravelly substratum or is underlain by siltstone.

Permeability is moderate in the Revel soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

The Welcome soil is deep and well drained. It formed in a mixture of volcanic ash, glacial till, colluvium, and slope alluvium derived dominantly from sandstone. Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. When mixed to a depth of 6 inches, the surface layer is dark yellowish brown loam. The subsoil is dark yellowish brown loam

17 inches thick. The upper 12 inches of the substratum is olive brown sandy loam. The lower part is light olive brown sandy loam. It is underlain by sandstone at a depth of 52 inches. The depth to sandstone ranges from 40 to 60 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is sandy loam or silt loam. In other areas the soil has a gravelly substratum, is more than 60 inches deep to sandstone, or is underlain by siltstone.

Permeability is moderate in the Welcome soil. Available water capacity also is moderate. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate.

Typically, the Rock outcrop is sandstone. It is hard and generally unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder and western redcedar. The common understory plants are red huckleberry, Oregongrape, western swordfern, salal, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir on the Revel soil is 121. On the basis of a 50-year site curve, it is 91. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 116 cubic feet per acre per year, occurring at age 60. Estimates of the site index or growth rate for western hemlock have not been made.

On the basis of a 100-year site curve, the mean site index on the Welcome soil is 129 for western hemlock and 135 for Douglas fir. On the basis of a 50-year site curve, it is 89 for western hemlock and 106 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 198 cubic feet per acre per year, occurring at age 50. For Douglas fir, it is 139 cubic feet per acre per year, occurring at age 70. Yields are reduced by the extent of the Rock outcrop. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. The pattern of the Rock outcrop on the landscape results in a discontinuous slope, which hinders the use of cable yarding systems. The trees can break if they are felled on the Rock outcrop. Because most of the roots are

concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soils are moist and a moderate degree of puddling when the soils are wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in soil productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Douglas fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

The Revel and Welcome soils are in capability subclass VIIe. The Rock outcrop is in capability subclass VIIs.

**128-Rinker very channery silt loam, 8 to 30 percent slopes.** This moderately deep, well drained soil is on mountain back slopes and shoulder slopes. It formed in a mixture of volcanic ash and colluvium derived from phyllite. The native vegetation is mainly conifers and shrubs. 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 period is about 130 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown very channery silt loam. The subsoil is dark yellowish

brown very channery silt loam 4 inches thick. The substratum is olive brown very channery loam 19 inches thick. Phyllite is at a depth of about 30 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is channery silt loam or very channery loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Montborne and Sorensen soils, soils that are less than 20 inches deep to phyllite or dense glacial till, stony areas, Rock outcrop, and Rinker soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Rinker soil. Available water capacity also is moderate. The 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 Douglas fir are the main woodland species. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are salal, Oregongrape, western swordfern, western brackenfern, and vine maple.

On the basis of a 100-year site curve, the mean site index is 157 for western hemlock and is estimated to be 146 for Douglas fir. On the basis of a 50-year site curve, it is 110 for western hemlock and is estimated to be 107 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 249 cubic feet per acre per year, occurring at age 50. For Douglas fir, it is about 153 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, the snowpack limits the use of equipment and restricts access from January through March. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Phyllite, a poor-quality rock for road construction, is readily available. Extra rock is needed to maintain a stable, uniform road surface. Cut and fill slopes tend to slump when wet. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by

Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass IVe.

**129-Rinker very channery silt loam, 30 to 60 percent slopes.** This moderately deep, well drained soil is on mountain back slopes and shoulder slopes. It formed in a mixture of volcanic ash and colluvium derived from phyllite. The native vegetation is mainly conifers and shrubs. 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 period is about 130 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown very channery silt loam. The subsoil is dark yellowish brown extremely channery silt loam 4 inches thick. The substratum is olive brown extremely channery loam 19 inches thick. Phyllite is at a depth of about 30 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is channery silt loam or very channery loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Montborne and Sorensen soils, soils that are less than 20 inches deep to phyllite or dense glacial till, stony areas, Rock outcrop, and Rinker soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Rinker soil. Available water capacity also is moderate. The 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. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are salal, Oregongrape, western swordfern, western brackenfern, and vine maple.

On the basis of a 100-year site curve, the mean site index is estimated to be 157 for western hemlock and is 146 for Douglas fir. On the basis of a 50-year site curve, it is estimated to be 110 for western hemlock and is 107 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 249 cubic feet per acre per year, occurring at age 50.

For Douglas fir, it is about 153 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Phyllite, a poor-quality rock for road construction, is readily available. Extra rock is needed to maintain a stable, uniform road surface. Cut and fill slopes tend to slump when wet. Soil creep is common on this unit.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**130-Riverwash.** This map unit is on river bottom land that is frequently flooded. Slopes are 0 to 2 percent. Areas are irregular in shape and are 5 to 100 acres in size. The native vegetation is mainly small trees, scattered shrubs, and grass, although most areas are unvegetated. Elevation is 40 to 900 feet. The average annual precipitation is 30 to 60 inches, the average annual air temperature is 47 to 50 degrees F, and the average frost-free period is 150 to 190 days.

No single profile is representative of this map unit. One of the more commonly observed ones, however, has a surface layer of very gravelly sand. The

underlying layers are stratified gravelly sand to extremely gravelly coarse sand to a depth of 60 inches or more.

Included in this unit are small areas of Pilchuck and Snoqualmie soils on flood plains, Xerorthents on low terraces, and bodies of water. Included areas make up about 15 percent of the total acreage.

Permeability is very rapid in the Riverwash. Available water capacity is low. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface to a depth of 2 feet throughout the year. Runoff is very slow, and the hazard of water erosion is severe because of the flooding and channeling. Channeling and deposition are common along streambanks. This unit is subject to frequent, long and very long periods of flooding from October through July.

This unit is used for wildlife habitat or recreation. It can be used as a source of sand and gravel; however, this use must be weighed against the destruction of riverine habitat that will be caused by obtaining the sand and gravel. The main limitations in the areas used as woodland, pasture, or cropland are the frequent flooding and the lack of soil fertility.

This map unit is in capability subclass VIIIw.

**131-Rock outcrop.** This map unit is on mountainsides and ridges. Slopes are 70 to 100 percent or more. Areas are irregular in shape and are 5 to 400 acres in size. Elevation is 100 to 5,500 feet.

Typically, the Rock outcrop is sandstone, phyllite, dunite, or metasedimentary rocks. It is hard and generally unweathered. It occurs as steep cliffs and irregular formations.

Included in this unit are small areas of soils that were too small to map at the selected scale and small areas of Rubbleland.

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

This unit is used for rock quarries or wildlife habitat.

This map unit is in capability subclass VIIIs.

**132-Rock outcrop-Kulshan complex, 60 to 90 percent slopes.** This map unit is on mountain back slopes and ridges. The Rock outcrop is on 60 to 90 percent slopes, and the Kulshan soil is on 60 to 80 percent slopes. The native vegetation is mainly conifers and shrubs. Elevation is 3,500 to 4,500 feet. The average annual precipitation is about 100 inches, the average annual air temperature is about 40 degrees F, and the average frost-free period is about 85 days.

This unit is 55 percent Rock outcrop and 25 percent Kulshan loam. The components of this unit occur as areas so intricately intermingled that mapping them

separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Shuksan and Gallup soils, soils that are less than 20 inches deep and that have a range in rock fragment content, organic soils in depressions, and Kulshan soils that have slopes of less than 60 percent. Included areas make up about 20 percent of the total acreage.

Typically, the Rock outcrop is sandstone or conglomerate. It is hard and generally unweathered. It occurs as steep cliffs and irregular formations.

The Kulshan soil is moderately deep and well drained. It formed in volcanic ash, loess, colluvium, and slope alluvium derived dominantly from sandstone. Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 8 inches, the surface layer is dark brown loam. The upper 15 inches of the subsoil is dark brown and very dark grayish brown silt loam. The lower 4 inches is dark brown gravelly loam. Sandstone is at a depth of about 27 inches. The depth to sandstone ranges from 20 to 40 inches. In some areas the surface layer is silt loam or gravelly loam. In other areas the soil has a very gravelly subsoil or is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Kulshan soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock and Pacific silver fir are the main woodland species. Among the trees of limited extent is mountain hemlock. The common understory plants are blueleaved huckleberry, bunchberry dogwood, and longtube twinflower.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 93. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 110 cubic feet per acre per year, occurring at age 60. Yields are reduced by the extent of the Rock outcrop. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, the Rock outcrop, snowpack, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. Cable yarding systems generally are used on this unit. The pattern of the Rock outcrop on the landscape results in a discontinuous slope, which hinders the use of cable yarding systems. The trees can break if they are felled on the Rock

outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock and Pacific silver fir seedlings. Because of the slope, planting seedlings is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the Kulshan soil is wet and winds are strong.

The Rock outcrop is in capability subclass VIIIs. The Kulshan soil is in capability subclass VIIe.

**133-Rubble land.** This map unit is on talus slopes at the base of rock outcrops. It consists of angular stones and boulders. Slopes are 30 to 100 percent. The native vegetation is mainly huckleberry, ferns, and forbs, which are sparsely distributed over the unit. Elevation is 2,000 to 4,000 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is 40 to 43 degrees F, and the average frost-free period is 80 to 100 days.

Typically, this unit consists of loosely piled angular stones and boulders to a depth of 60 inches.

Included in this unit are small areas of Rock outcrop and areas where soil is within a depth of 60 inches.

This unit is used for wildlife habitat or as a source of aggregate.

This map unit is in capability subclass VIIIs.

### **134-Saar gravelly silt loam, 5 to 30 percent slopes.**

This moderately deep, moderately well drained soil is on mountain back slopes and shoulder slopes. It formed in a mixture of volcanic ash, colluvium, and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 7 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown gravelly silt loam. The upper 15 inches of the subsoil is organic stained, dark brown very gravelly loam and very gravelly silt loam. The lower 7 inches is dark brown very gravelly loam. Dense glacial till that crushes to extremely gravelly loam is at a depth of 29 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly loam or very gravelly silt loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to dense glacial till or bedrock, has a less developed subsoil, has less than 6 percent organic carbon in the upper part of the subsoil and lower part of the surface layer, or has more than 6 percent organic carbon throughout the profile.

Included in this unit are small areas of Hartnit, Kulshan, Clendenen, and Gallup soils, Rock outcrop, poorly drained mineral and organic soils in depressions, and Saar soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Saar soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through May. 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. Among the trees of limited extent are mountain hemlock and western redcedar. The common understory plants are tall blue huckleberry, deer fern, red huckleberry, longtube twinflower, and bunchberry dogwood.

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, it is estimated to be 75. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 151 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds

are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

### **135-Saar gravelly silt loam, 30 to 60 percent slopes.**

This moderately deep, moderately well drained soil is on mountain back slopes and shoulder slopes. It formed in a mixture of volcanic ash, colluvium, and glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 7 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown gravelly silt loam. The upper 15 inches of the subsoil is organic stained, dark brown very gravelly loam. The

lower 7 inches is dark brown very gravelly loam. Dense glacial till that crushes to extremely gravelly loam is at a depth of 29 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly loam or very gravelly silt loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to dense glacial till or bedrock, has a less developed subsoil, has less than 6 percent organic carbon in the upper part of the subsoil and lower part of the surface layer, or has more than 6 percent organic carbon throughout the profile.

Included in this unit are small areas of Hartnit, Kulshan, Clendenen, and Gallup soils, Rock outcrop, poorly drained mineral and organic soils in depressions, and Saar soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Saar soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through May. 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. Among the trees of limited extent are mountain hemlock and western redcedar. The common understory plants are tall blue huckleberry, deer fern, red huckleberry, longtube twinflower, and bunchberry dogwood.

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, it is estimated to be 75. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 151 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily

available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

### **136-Saar-Hartnit complex, 5 to 40 percent slopes.**

This map unit is on mountain back slopes and plateaus. The native vegetation is mainly conifers and shrubs.. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 90 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 95 days.

This unit is 50 percent Saar gravelly silt loam and 35 percent Hartnit loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Clendenen and Gallup soils, soils that are less than 20 inches deep over bedrock, Rock outcrop, and Saar and Hartnit soils that have slopes of more than 40 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

The Saar soil is moderately deep and moderately well drained. It formed in a mixture of volcanic ash, colluvium, and glacial till. Typically, the surface is covered with a mat of needles, leaves, and twigs 5 inches thick. When mixed to a depth of 7 inches, the

surface layer is dark brown gravelly silt loam. The upper 9 inches of the subsoil is yellowish red very gravelly loam. The lower 10 inches is olive brown very gravelly loam. Dense glacial till that crushes to extremely gravelly sandy loam is at a depth of 26 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly silt loam or very gravelly loam. In other areas the soil has less than 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to dense glacial till or bedrock, has a less developed subsoil, has less than 6 percent organic carbon in the upper part of the subsoil or lower part of the surface layer, or has more than 6 percent organic carbon throughout the profile.

Permeability is moderate in the upper part of the Saar soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through May. Runoff is slow, and the hazard of water erosion is slight.

The Hartnit soil is moderately deep and well drained. It formed in a mixture of volcanic ash and colluvium over glacial till. Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown loam 4 inches thick. The upper 6 inches of the subsoil is organic stained, dark brown loam. The lower 7 inches is dark yellowish brown loam. The upper 10 inches of the substratum is olive brown gravelly loam. The lower 12 inches is dark yellowish brown and olive brown very gravelly loam. Sandstone is at a depth of about 39 inches. The depth to bedrock ranges from 20 to 40 inches. In some areas the surface layer is loam or gravelly silt loam. In other areas the soil has less than 6 percent organic carbon in the upper part of the subsoil, has a less developed subsoil, or is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Hartnit soil. Available water capacity also is moderate. The 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. Among the trees of limited extent are mountain hemlock, Douglas fir, and western redcedar. The common understory plants are tall blue huckleberry, deer fern, red huckleberry, longtube twinflower, and bunchberry dogwood.

On the basis of a 100-year site curve, the mean site index for western hemlock on both soils is estimated to be 105. On the basis of a 50-year site curve, it is estimated to be 75. The highest average growth rate in

unmanaged, even-aged stands of western hemlock is about 151 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the dense glacial till or bedrock, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

The Saar and Hartnit soils are in capability subclass VIe.

**137-Sandun very gravelly sandy loam, 5 to 30 percent slopes.** This very deep, well drained soil is on outwash terraces, terrace escarpments, and mountain foot slopes. It formed in a mixture of volcanic ash and loess over glacial outwash derived dominantly from dunite. The native vegetation is mainly conifers and

shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 110 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer when mixed to a depth of 7 inches is dark reddish brown very gravelly sandy loam. The subsoil is dark brown very gravelly sandy loam 17 inches thick. The upper 12 inches of the substratum is dark yellowish brown very gravelly loamy sand. The lower part to a depth of 60 inches is olive brown very gravelly loamy sand. The depth to very gravelly sand or loamy sand ranges from 20 to 36 inches. In some areas the surface layer is gravelly sandy loam or very gravelly loam. In other areas the soil has more than 6 percent organic carbon in the upper part of the subsoil, is dominated by rock fragments other than dunite, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Jackman soils, soils that are moderately deep over bedrock or dense glacial till and are derived dominantly from dunite, and Sandun soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Sandun soil and very rapid in the substratum. Available water capacity is low. The effective rooting depth is 60 inches. 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. Among the trees of limited extent is red alder. The common understory plants are salal, red huckleberry, and western swordfern. Vegetation is somewhat stunted and sparse because of the toxicity of the dunite-derived soil.

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, it is estimated to be 95. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 209 cubic feet per acre per year, occurring at age 50. Estimates of the site index or growth rate for Douglas fir have not been made.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, the snowpack limits the use of equipment and restricts access from January through March. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road

construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement. Steep skid trails and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings, which are adapted to the toxicity of dunite soils. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. Trees grow poorly and lack vigor on soils that are derived from dunite.

This map unit is in capability subclass IVe.

**138-Sandun very gravelly sandy loam, 30 to 60 percent slopes.** This very deep, well drained soil is on terrace escarpments and mountain foot slopes. It formed in a mixture of volcanic ash and loess over glacial outwash derived dominantly from dunite. The native vegetation is mainly conifers and shrubs. Elevation is 1,200 to 2,500 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 110 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown very gravelly sandy loam. The subsoil is dark brown very gravelly sandy loam 17 inches thick. The upper 12 inches of the substratum is dark yellowish brown very gravelly loamy sand. The lower part to a depth of 607 inches is olive brown very gravelly loamy sand. The depth to very gravelly sand or loamy sand ranges from 20 to 36 inches. In some areas the surface layer is gravelly sandy loam or very gravelly loam. In other areas the soil has more than 6 percent organic carbon in the upper part of the subsoil, is dominated by rock fragments other than dunite, or has a substratum of very gravelly sandy loam.

Included in this unit are small areas of Jackman soils, soils that are moderately deep over bedrock or dense glacial till and are derived dominantly from dunite, and Sandun soils that have slopes of more than

60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Sandun soil and very rapid in the substratum. Available water capacity is low. 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. Among the trees of limited extent is red alder. The common understory plants are salal, red huckleberry, and western swordfern. Vegetation is somewhat stunted and sparse because of the toxicity of the dunite-derived soil.

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, it is estimated to be 95. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 209 cubic feet per acre per year, occurring at age 50. Estimates of the site index or growth rate for Douglas fir have not been made.

The main limitations affecting timber harvesting are the slope, occasional snowpack, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the hazards of displacement and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. Reforestation can be accomplished by planting western hemlock or Douglas

fir seedlings, which are adapted to the toxicity of dunite soils. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. Trees grow poorly and lack vigor on soils that are derived from dunite.

This map unit is in capability subclass VIIe.

**139-Sehome loam, 2 to 8 percent slopes.** This moderately deep, moderately well drained soil is on glacially modified mountain foot slopes and in valleys. It formed in a mixture of volcanic ash and loess over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 200 to 1,100 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 0.5 inch thick. The surface layer is dark brown loam 11 inches thick. The subsoil is dark yellowish brown gravelly loam 15 inches thick. Dense glacial till that crushes to very gravelly loam is at a depth of 26 inches. The depth to dense glacial till ranges from 24 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is silt loam, gravelly silt loam, or gravelly loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil, is 40 to 60 inches deep to dense glacial till, or has dominantly phyllitic rock fragments.

Included in this unit are small areas of Nati, Squires, Barneston, Winston, and Blethen soils, small areas of Bellingham soils in depressions, soils that are similar to the Sehome soil but have a clayey or very gravelly sand substratum, and Sehome soils that have slopes of more than 8 percent or less than 2 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Sehome soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 24 to 40 inches. Water is perched above the dense glacial till from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. Some areas are used for hay and pasture or as a site for homes.

The main limitations in the areas used for hay and pasture are the seasonal high water table and the hazard of erosion during periods of reestablishment. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and water erosion. Some areas have been partially drained, but adequate drainage systems have not been maintained. The wetness can be reduced in some areas

by diversions, which intercept water, and by open ditches, which remove excess water.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are salal, Oregon grape, western swordfern, red huckleberry, vine maple, western brackenfern, and salmonberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 180. On the basis of a 50-year site curve, it is 135. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 191 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitation for homesite development is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The dense glacial till is rippable and, therefore, is not a serious limitation for most engineering uses. The main limitations on sites for septic tank absorption fields are the very slow permeability in the dense glacial till and the seasonal high water table. These limitations can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour. Installing the absorption field in the loamy

subsoil or in fill approved by the health district also helps to overcome these limitations. This map unit is in capability subclass IIe.

**140-Sehome loam, 8 to 15 percent slopes.** This moderately deep, moderately well drained soil is on mountain foot slopes. It formed in a mixture of volcanic ash and loess over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 900 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark brown loam 4 inches thick. The upper 9 inches of the subsoil is strong brown gravelly loam. The lower 26 inches is yellowish brown gravelly loam. Dense glacial till that crushes to very gravelly loam is at a depth of 39 inches. The depth to dense glacial till ranges from 24 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is silt loam, gravelly silt loam, or gravelly loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil, is 40 to 60 inches deep to dense glacial till, or has dominantly phyllitic rock fragments.

Included in this unit are small areas of Nati, Squires, Barneston, Winston, and Blethen soils, small areas of Bellingham soils in depressions, soils that are similar to the Sehome soil but have a clayey or gravelly sand substratum, and Sehome soils that have slopes of more than 15 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Sehome soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 24 to 40 inches. Water is perched above the dense glacial till from December through April. Runoff is medium, and the hazard of water erosion is moderate.

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

The main limitations in the areas used for hay and pasture are the seasonal high water table and the hazard of water erosion. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and water erosion. Some areas have been partially drained, but adequate drainage systems have not been maintained. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are salal, Oregongrape, western swordfern, red huckleberry, vine maple, western brackenfern, and salmonberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 180. On the basis of a 50-year site curve, it is 135. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 191 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitations for homesite development are the slope and the seasonal wetness. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. Excavation for building sites is limited by the hardpan. The hardpan is rippable and, therefore, is not a serious limitation for most engineering uses.

The main limitations on sites for septic tank absorption fields are the very slow permeability in the cemented pan, the slope, and the seasonal wetness. These limitations can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour. Installing the absorption field in the loamy subsoil or in fill approved

by the health district also helps to overcome these limitations. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope.

This map unit is in capability subclass IIIe.

**141-Sehome gravelly loam, 15 to 30 percent slopes.**

This moderately deep, moderately well drained soil is on glacially modified mountain foot slopes. It formed in a mixture of volcanic ash and loess over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 900 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark yellowish brown gravelly loam 12 inches thick. The upper 13 inches of the subsoil is light olive brown gravelly loam. The lower 13 inches is light brownish gray and yellowish brown, mottled gravelly loam. Dense glacial till that crushes to very gravelly loam is at a depth of 38 inches. The depth to dense glacial till ranges from 24 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is loam, silt loam, or gravelly silt loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil, is 40 to 60 inches deep to glacial till, or has dominantly phyllitic rock fragments.

Included in this unit are small areas of Squires, Barneston, Winston, and Blethen soils, soils that are similar to the Sehome soil but have a clayey or gravelly sand substratum, and Sehome soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Sehome soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 24 to 40 inches. Water is perched above the dense glacial till from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are salal, Oregon grape, western swordfern, red huckleberry, vine maple, western brackenfern, and salmonberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 180. On the basis of a 50-year site curve, it is 135. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 191 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the

muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass IVe.

**142-Sehome gravelly loam, 30 to 60 percent slopes.**

This moderately deep, moderately well drained soil is on glacially modified mountain foot slopes. It formed in a mixture of volcanic ash and loess over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 900 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark yellowish brown gravelly loam 12 inches thick. The upper 13 inches of the subsoil is light olive brown gravelly loam. The lower 13 inches is light brownish gray and yellowish brown, mottled gravelly loam. Dense glacial till that crushes to very gravelly loam is at a depth of 38 inches. The depth to dense glacial till ranges from 24 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is loam, silt loam, or gravelly silt loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil, is 40 to 60 inches deep to

dense glacial till, or has dominantly phyllitic rock fragments.

Included in this unit are small areas of Squires, Barneston, Winston, and Blethen soils, soils that are similar to the Sehome soil but have a clayey or gravelly sand substratum, and Sehome soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Sehome soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 24 to 40 inches. Water is perched above the dense glacial till from December through April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are salal, Oregongrape, western swordfern, red huckleberry, vine maple, western brackenfern, and salmonberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 180. On the basis of a 50-year site curve, it is 135. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 191 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

#### **143-Shalcar muck, drained, 0 to 2 percent slopes.**

This very deep, very poorly drained soil is in depressions on outwash terraces, till plains, and stream terraces. It has been artificially drained. It formed in herbaceous and woody organic deposits, overlying alluvium and glaciofluvial deposits. The native vegetation is mainly shrubs, forbs, and trees. Elevation is near sea level to 600 feet above sea level. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is black muck 37 inches thick. The upper 15 inches of the underlying material is very dark grayish brown loam. The lower part to a depth of 60 inches is gravelly sand. It is variegated but is dominantly dark gray. In some areas the soil has hemic material in the surface layer or is not underlain by gravelly sand. In other areas the underlying material is below a depth of 51 inches.

Included in this unit are small areas of Bellingham, Snohomish, Puget, Sumas, Fishtrap, and Hale soils, ponded areas, and Shalcar soils that have not been drained or have slopes of more than 2 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Shalcar soil and very rapid in the lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 0.5 foot to 1.5 feet from October through May. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion.

This unit is used mainly for hay and pasture or as cropland. The included undrained Shalcar soils are used as woodland.

The main limitation in the areas used for hay and pasture are the high water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Grazing when the soil is wet results in compaction of the surface layer and poor tilth.

The main limitations in the areas used as cropland are the high water table and the soil acidity. This soil is well suited to most crops commonly grown in the survey area if adequate drainage systems are maintained. The principal crops are potatoes, blueberries, and corn silage. Tile drains and field ditches should be maintained. They permit fieldwork to be conducted

earlier in the spring and increase the yields. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Subsidence is minimized if the water table is maintained directly below the root zone during the growing season and then allowed to return to the surface during the winter. Using regulating structures in open ditches as a means of subirrigation reduces the extent of subsidence. In summer, irrigation is required for maximum production. Soil acidity can be reduced by adding lime.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, lodgepole pine, and Sitka spruce. The common understory plants are willow, Douglas spirea, salmonberry, stinging nettle, and sedges.

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 in unmanaged, even-aged stands of red alder is about 92 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The high water table limits the use of equipment to dry periods. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If the unit is used for homesite development, the main limitations are the high water table and the low strength. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. If buildings are constructed on this soil, the muck should be excavated

or the buildings should be constructed on piles anchored in the mineral soil. The design of buildings and roads can offset the limited ability of the soil to support a load. The main limitation on sites for septic tank absorption fields is the wetness. Installing the absorption field in fill approved by the health district helps to compensate for this limitation.

This map unit is in capability subclass IIw.

**144-Shalcar and Fishtrap soils, 0 to 2 percent slopes.** This map unit is in backswamps on flood plains and in depressional areas on till plains, outwash terraces, and stream terraces. The soils in this unit formed in herbaceous and woody organic deposits overlying glacial fluvial deposits. The native vegetation is mainly shrubs and forbs. Elevation is 300 to 1,000 feet. The average annual precipitation is about 50 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 60 percent Shalcar muck and 30 percent Fishtrap muck. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of mineral soils that are ponded, Pangborn soils, and areas where the soils have been partially drained. Included areas make up about 10 percent of the total acreage.

The Shalcar soil is very deep and very poorly drained. Typically, the surface layer is very dark brown muck 25 inches thick. The underlying material to a depth of 60 inches is gray and greenish gray silty clay loam. The depth to mineral material ranges from 16 to 51 inches. In some areas the surface layer is mucky silt loam or hemic material.

Permeability is moderate in the Shalcar soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface from October through May. Runoff is very slow or ponded, and there is no hazard of erosion.

The Fishtrap soil is very deep and very poorly drained. Typically, the surface layer is black muck 16 inches thick. The upper 22 inches of the underlying material is black muck. The next 5 inches is dark gray silt loam. The lower part to a depth of 60 inches is sand. It is variegated but is dominantly dark gray. In some areas the surface layer is mucky silt loam or hemic material.

Permeability is moderate in the upper part of the Fishtrap soil and very rapid in the lower part of the underlying material. Available water capacity is high. The effective rooting depth is limited by a seasonal high

water table, which is at or above the surface from October through May. Runoff is very slow or ponded, and there is no hazard of erosion.

This unit is used for wildlife habitat.

The Shalcar and Fishtrap soils are in capability subclass VIw.

**145-Shuksan gravelly silt loam, 5 to 30 percent slopes.** This moderately deep, moderately well drained soil is on mountain slopes and plateaus. It formed in a mixture of volcanic ash, loess, and colluvium over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 3,000 to 4,500 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and wood fragments 9 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown gravelly silt loam. The upper 8 inches of the subsoil is organic stained, strong brown gravelly silt loam. The lower 20 inches is organic stained, dark brown and dark yellowish brown very gravelly loam. Dense glacial till that crushes to very gravelly sandy loam is at a depth of 35 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is silt loam or gravelly loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is 40 to, 60 inches deep to dense glacial till or bedrock, has a less developed subsoil, or has less than 6 percent organic carbon in the upper part of the subsoil and lower part of the surface layer.

Included in this unit are small areas of Kulshan, Hartnit, Clendenen, and Gallup soils, Rock outcrop, poorly drained mineral and organic soils in depressions, and Shuksan soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Shuksan soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through May. 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. Among the trees of limited extent are mountain hemlock and western redcedar. The common understory plants are tall blue huckleberry, red huckleberry, bunchberry dogwood, longtube twinflower, and deer fern.

On the basis of a 100-year site curve, the mean site

index for western hemlock is estimated to be 98. On the basis of a 50-year site curve, it is estimated to be 70. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 118 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack and the muddiness caused by seasonal wetness. During an average year, the snowpack limits the use of equipment and restricts access from November through May. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIe.

**146-Shuksan gravelly silt loam, 30 to 60 percent slopes.** This moderately deep, moderately well drained soil is on mountain slopes and plateaus. It formed in a mixture of volcanic ash, loess, and colluvium over

glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 3,000 to 4,500 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, leaves, twigs, and wood fragments 9 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown gravelly silt loam. The upper 8 inches of the subsoil is organic stained, strong brown gravelly silt loam. The lower 20 inches is organic stained, dark brown and dark yellowish brown very gravelly loam. Dense glacial till that crushes to very gravelly sandy loam is at a depth of 35 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is silt loam or gravelly loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to dense glacial till or bedrock, has a less developed subsoil, or has less than 6 percent organic carbon in the upper part of the subsoil and lower part of the surface layer.

Included in this unit are small areas of Kulshan, Hartnit, Clendenen, and Gallup soils, Rock outcrop, poorly drained mineral and organic soils in depressions, and Shuksan soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Shuksan soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through May. 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. Among the trees of limited extent are mountain hemlock and western redcedar. The 'common understory plants are tall blue huckleberry, red huckleberry, bunchberry dogwood, longtube twinflower, and deer fern.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 98. On the basis of a 50-year site curve, it is estimated to be 70. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 118 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During

an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**147-Shuksan-Kulshan-Rock outcrop complex, 50 to 80 percent slopes.** This map unit is on mountain slopes, plateaus, and ridges. The native vegetation is mainly conifers and shrubs. Elevation is 3,000 to 4,500 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 90 days.

This unit is 35 percent Shuksan gravelly silt loam, 25 percent Kulshan loam, and 20 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately

was not practical at the selected scale of mapping.

Included in this unit are small areas of Clendenen and Gallup soils, poorly drained mineral soils in swales, soils that are less than 20 inches deep to dense glacial till or bedrock, stony areas, slump areas, and Shuksan and Kulshan soils that have slopes of more than 80 percent or less than 50 percent. Included areas make up about 20 percent of the total acreage.

The Shuksan soil is moderately deep and moderately well drained. It formed in a mixture of volcanic ash, loess, and colluvium over glacial till. Typically, the surface is covered with a mat of needles, leaves, twigs, and wood fragments 9 inches thick. When mixed to a depth of 7 inches, the surface layer is dark reddish brown gravelly silt loam. The upper 8 inches of the subsoil is organic stained, strong brown gravelly silt loam. The lower 20 inches is organic stained, dark brown and dark yellowish brown very gravelly loam. Dense glacial till that crushes to very gravelly sandy loam is at a depth of 35 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is silt loam or gravelly loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil, is 40 to 60 inches deep to dense glacial till or bedrock, has a less developed subsoil, or has less than 6 percent organic carbon in the upper part of the subsoil and lower part of the surface layer.

Permeability is moderate in the upper part of the Shuksan soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through May. Runoff is rapid, and the hazard of water erosion is severe.

The Kulshan soil is moderately deep and well drained. It formed in volcanic ash, loess, colluvium, and slope alluvium derived dominantly from sandstone. Typically, the surface is covered with a mat of needles, leaves, twigs, and bark 7 inches thick. When mixed to a depth of 8 inches, the surface layer is dark red loam. The upper 6 inches of the subsoil is organic stained, yellowish red gravelly loam. The lower 16 inches is yellowish red and dark reddish brown gravelly loam and cobbly loam. Sandstone is at a depth of about 30 inches. The depth to sandstone ranges from 20 to 40 inches. In some areas the surface layer is silt loam or gravelly loam. In other areas the soil has a very gravelly subsoil or is 40 to 60 inches deep over bedrock.

Permeability is moderate in the Kulshan soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is sandstone or

metasedimentary rock. It is hard and generally unweathered. 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. Among the trees of limited extent are mountain hemlock and western redcedar. The common understory plants are tall blue huckleberry, red huckleberry, bunchberry dogwood, longtube twinflower, and deer fern.

On the basis of a 100-year site curve, the mean site index for western hemlock on the Shuksan soil is estimated to be 98. On the basis of a 50-year site curve, it is estimated to be 70. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 118 cubic feet per acre per year, occurring at age 60.

On the basis of a 100-year site curve, the mean site index for western hemlock on the Kulshan soil is estimated to be 93. On the basis of a 50-year site curve, it is estimated to be 65. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 110 cubic feet per acre per year, occurring at age 60. Yields are reduced by the extent of the Rock outcrop. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit. Estimates of the site index or growth rate for Pacific silver fir have not been made.

The main limitations affecting timber harvesting are the slope, the Rock outcrop, snowpack, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. The pattern of the Rock outcrop on the landscape results in a discontinuous slope, which hinders the use of cable yarding systems. These systems generally are used on this unit. The trees can break if they are felled on the Rock outcrop. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity.

Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Locating roads on midslopes requires extensive cutting and filling, which remove land from production. Soil creep is common on this unit. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting

timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. Because of the slope, planting seedlings is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. Because the rooting depth is restricted by the bedrock or dense glacial till, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

The Shuksan and Kulshan soils are in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

**148-Skipopa silt loam, 0 to 8 percent slopes.** This very deep, somewhat poorly drained soil is on terraces. It formed in loess and volcanic ash over glaciolacustrine sediments. It is in convex areas and frequently on elongated ridges. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark brown silt loam 8 inches thick. The upper 4 inches of the subsoil is dark brown silt loam. The next 4 inches is dark yellowish brown, mottled silt loam. The lower 4 inches is brown and grayish brown, mottled silty clay loam. The upper 24 inches of the substratum is brown and dark brown, mottled silty clay loam. The lower part to a depth of 60 inches is light brownish gray and light yellowish brown, mottled silty clay loam. The depth to silty clay or silty clay loam ranges from 14 to 24 inches. In some areas the surface layer is loam. In other areas the substratum contains lenses of sand or is 18 to 35 percent clay.

Included in this unit are small areas of Bellingham, Labounty, and Shalcar soils in depressions and small areas of Skipopa soils that have slopes of more than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Skipopa soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 2 feet from October through June. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture. It also is used as woodland and as a site for homes. The main limitations in the areas used for hay and

pasture are the high water table and the very slow permeability. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. The water table limits the use of this unit to grasses unless a drainage system is installed. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Tile drains and field ditches are needed to lower the high water table if deep-rooted plants are to be grown. Some areas have been partially drained, mainly by open ditches, but adequate drainage systems have not been maintained. Installing a drainage system permits fieldwork to be conducted earlier in the spring and increases yields. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water.

Douglas fir and red alder are the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, and bigleaf maple. The common understory plants are western swordfern, salmonberry, red huckleberry, western brackenfern, and trailing blackberry.

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, it is 116 for Douglas fir and 97 for red alder. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 159 cubic feet per acre per year, occurring at age 60. For red alder, it is 113 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment and the hazard of windthrow are the main concerns affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy,

the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitation is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the very slow permeability and the seasonal high water table. These limitations can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour.

This map unit is in capability subclass IIIw.

**149--Skipopa-Blainegate complex, 0 to 8 percent slopes.** This map unit is on marine terraces characterized by a series of elongated ridges and swales. The Skipopa soil is on 0 to 8 percent slopes, and the Blainegate soil is on 0 to 1 percent slopes. The native vegetation is mainly trees and shrubs. Elevation is 20 to 200 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 50 percent Skipopa silt loam and 35 percent Blainegate silty clay. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Shalcar, Edmonds, and Tromp soils and small areas of Skipopa soils that have slopes of more than 8 percent. Included areas make up about 15 percent of the total acreage.

The Skipopa soil is very deep and somewhat poorly drained. It formed in loess and volcanic ash over glaciolacustrine sediments. Typically, the surface layer is dark brown silt loam 8 inches thick. The subsoil is 12 inches thick. In sequence downward, it is dark brown silt loam; dark yellowish brown, mottled silt loam; and brown and grayish brown, mottled silty clay loam. The upper 24 inches of the substratum is brown and yellowish brown, mottled silty clay loam. The lower part to a depth of 60 inches is light brownish gray and light yellowish brown, mottled silty clay. The depth to silty clay or silty clay loam ranges from 14 to 24 inches. In some areas the surface layer is loam. In other areas the substratum contains lenses of sand or is 18 to 35 percent clay.

Permeability is very slow in the Skipopa soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 2 feet from October through June. Runoff is slow, and the hazard of water erosion is slight.

The Blainegate soil is very deep and poorly drained. It formed in loess and marine deposits. Typically, the surface layer is very dark grayish brown silty clay loam 9 inches thick. The subsoil is dark gray, mottled clay 18 inches thick. The upper 18 inches of the substratum is gray, mottled clay. The lower part to a depth of 60 inches is light brownish gray, mottled clay. In some areas the surface layer is silty clay or mucky silty clay loam. In other areas the soil has 30 to 60 percent clay in the subsoil or substratum or has lenses of sand in the substratum.

Permeability is very slow in the Blainegate soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is within 1 foot of the surface from November through June. Runoff from the higher areas of the microrelief increases the poorly drained conditions in the depressions. Runoff is very slow, and there is no hazard of erosion.

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

The main limitations in the areas used for hay and pasture are the high water table and the very slow permeability. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soils are wet results in compaction of the surface layer and poor tilth. The water table limits the use of this unit to grasses unless a drainage system is installed. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Tile drains and field ditches are needed to lower the high water table if deep-rooted plants are to be grown.

Some areas have been partially drained, mainly by open ditches, but adequate drainage systems have not been maintained. Installing a drainage system permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water. The depressions in this unit generally are not connected and cannot be easily drained. As a result, the use of equipment in harvesting hay is limited.

Red alder and Douglas fir are the main woodland species. Among the trees of limited extent are western redcedar and western hemlock. The common understory plants are western swordfern, salmonberry, red huckleberry, western brackenfern, trailing

blackberry, and Douglas spirea.

On the basis of a 100-year site curve, the mean site index on the Skipopa soil is 151 for Douglas fir. On the basis of a 50-year site curve, it is 116 for Douglas fir and 97 for red alder. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 159 cubic feet per acre per year, occurring at age 60. For red alder, it is 113 cubic feet per acre per year, occurring at age 40.

On the basis of a 50-year site curve, the mean site index for red alder on the Blainegate soil is 85. The highest average growth rate in unmanaged, even-aged stands of red alder is 92 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soils are moist and a high degree of puddling when the soils are wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling mortality, seeding establishment, and the hazard of windthrow are the main concerns affecting timber production. The high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting Douglas fir, western redcedar, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soils are wet and winds are strong.

If this unit is used for homesite development, the main limitation is the high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the very slow permeability and the seasonal high water table. These limitations can be overcome by using interceptor drains,

by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour.

The Skipopa soil is in capability subclass IIIw. The Blainegate soil is in capability subclass VIw.

**150-Skykomish very gravelly loam, 3 to 30 percent slopes.** This very deep, somewhat excessively drained soil is on outwash terraces. It formed in volcanic ash and glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,400 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 45 degrees F, and the average frost-free period is about 120 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 10 inches thick. When mixed to a depth of 7 inches, the surface layer is dark yellowish brown very gravelly loam. The subsoil also is dark yellowish brown very gravelly loam 7 inches thick. The upper 16 inches of the substratum is dark yellowish brown extremely gravelly loamy sand. The lower part to a depth of 60 inches is brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 14 to 30 inches. In some areas the surface layer is very gravelly sandy loam or gravelly loam. In other areas the soil has a substratum of very gravelly sandy loam or has 15 to 35 percent rock fragments in the subsoil and substratum.

Included in this unit are small areas of Oakes and Cupples soils and small areas of Skykomish soils that have slopes of more than 30 percent or less than 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the upper part of the Skykomish soil and very rapid in the substratum. Available water capacity is moderate. The effective rooting depth is 60 inches. 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. Among the trees of limited extent are western redcedar and red alder. The common understory plants are red huckleberry, western swordfern, western brackenfern, salal, and Oregongrape.

On the basis of a 100-year site curve, the mean site index is 148 for western hemlock and 136 for Douglas fir. On the basis of a 50-year site curve, it is 106 for western hemlock and 108 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 234 cubic feet per acre per year, occurring at age 50. For Douglas fir, it is 142 cubic feet per acre per year, occurring at age 70.

The main limitation affecting timber harvesting is

occasional snowpack. During an average year, the snowpack limits the use of equipment and restricts access from January through March. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available. Cut and fill slopes tend to ravel when dry. Steep skid trails and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and establishment are the main concerns affecting timber production. Reforestation can be accomplished by planting western hemlock or Douglas fir seedlings. A low content of moisture in the surface layer during the growing season hinders the survival of planted and naturally established seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVe.

**151-Snohomish silt loam, drained, 0 to 2 percent slopes.** This very deep, poorly drained soil is on flood plains. It has been artificially drained. It formed in alluvium underlain by organic material. The native vegetation is mainly trees and shrubs. Elevation is 20 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 period is about 170 days.

Typically, the surface layer is dark grayish brown silt loam 6 inches thick. The upper 11 inches of the underlying material is dark grayish brown, mottled silt loam. The lower part to a depth of 60 inches is dark reddish brown sapric material. The depth to sapric material ranges from 14 to 30 inches. In some areas the surface layer is silty clay loam or mucky silt loam. In other areas the soil has 10 to 18 percent clay in the underlying material, has a dark brown surface layer, or has hemic underlying material.

Included in this unit are small areas of Puget, Oridia, and Pangborn soils and undrained Snohomish soils. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Snohomish soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 3 feet from November through April. Runoff is very slow, and there is no

hazard of erosion. In most areas this soil is subject to occasional, brief periods of flooding from November through April. Downstream from Lynden, however, it is subject to frequent, brief periods of flooding from December through February.

This unit is used mainly for hay and pasture or as cropland. The included undrained Snohomish soils are used as woodland.

The main limitations in the areas used for hay and pasture are the high water table and the moderately slow permeability. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. In areas where the drainage system is not maintained or in areas that do not have drainage, the water table limits the use of this unit to grasses. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

The main limitations in the areas used as cropland are the high water table and the moderately slow permeability. This soil is well suited to most crops commonly grown in the survey area if adequate drainage systems are maintained. The principal crops are peas, sweet corn, beans, small grain, and corn silage. Tile drains and field ditches should be maintained. They permit fieldwork to be conducted earlier in the spring and increase the yields of perennial crops. Drainage tile should be closely spaced because of the moderately slow permeability. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Subsidence is minimized if the water table is maintained directly below the root zone during the growing season and then allowed to return to the surface during the winter. Using regulating structures in open ditches as a means of subirrigation reduces the extent of subsidence. In summer, irrigation is required for maximum production.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, and Sitka spruce. The common understory plants are Douglas spirea, salmonberry, rose, stinging nettle, and sedges.

On the basis of a 50-year site curve, the mean site index for red alder is estimated to be 80. The highest average growth rate in unmanaged, even-aged stands of red alder is about 84 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the occasional flooding and the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft

when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitations are the high water table and the hazard of flooding. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. If buildings are constructed on this soil, the underlying muck should be excavated or the buildings should be constructed on piles anchored in the mineral soil below the muck. The design of buildings and roads can offset the limited ability of the soil to support a load. The main limitations on sites for septic tank absorption fields are the hazard of flooding, the high water table, and the moderately slow permeability. Installing the absorption field in fill approved by the health district helps to overcome these limitations.

This map unit is in capability subclass IIw.

**152-Snoqualmie gravelly loamy sand, 0 to 3 percent slopes.** This very deep, somewhat excessively drained soil is on flood plains and low river terraces. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is 300 to 900 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 6 inches, the surface layer is very dark grayish brown gravelly loamy sand. The underlying

material to a depth of 60 inches is very dark gray and dark gray very gravelly sand. In some areas the surface layer is loamy sand, sandy loam, or sand. In other areas the soil has a substratum with 15 to 35 percent rock fragments or has strata of sandy loam.

Included in this unit are small areas of Pilchuck soils, Riverwash, poorly drained mineral and organic soils in drainageways, or Snoqualmie soils that have slopes of more than 3 percent. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the Snoqualmie soil. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is very slow, and the hazard of water erosion is severe because of the flooding and channeling. A seasonal high water table is at a depth of 3 to 5 feet from November through April. This soil is subject to occasional, brief periods of flooding from November through April during periods of snowmelt and rainfall.

This unit is used as woodland and for wildlife habitat. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and black cottonwood. The common understory plants are western swordfern, vine maple, red huckleberry, trailing blackberry, bunchberry dogwood, and salmonberry.

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, it is estimated to be 110. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 149 cubic feet per acre per year, occurring at age 65.

The main concern affecting timber harvesting is the hazard of flooding. This limits the use of equipment to dry periods. Generally, the surface layer is loose when dry. As a result, the use of wheeled and tracked equipment is limited. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles for road construction are readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement.

Seedling mortality and seedling establishment are the main concerns affecting timber production. The seedling survival rate is reduced by droughtiness in the surface layer and may be low in areas where flooding occurs. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings.

Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIw.

**153-Sorensen very gravelly silt loam, 8 to 30 percent slopes.** This very deep, well drained soil is on mountain back slopes and toe slopes. It formed in a mixture of volcanic ash, loess, and colluvium derived from glacial till. The till was derived from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,900 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and the average frost-free period is about 130 days.

Typically, the surface is covered with a mat of needles and twigs 4 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown very gravelly silt loam. The upper 6 inches of the subsoil is yellowish brown very gravelly loam. The lower 13 inches is light brownish gray very gravelly loam. The substratum to a depth of 60 inches is light olive gray very gravelly silt loam. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is not dominated by phyllite rock fragments.

Included in this unit are small areas of Montborne, Rinker, and Skykomish soils and small areas of Sorensen soils that have slopes of more than 30 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Sorensen soil. Available water capacity is high. The effective rooting depth is 60 inches. 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. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are red huckleberry, western swordfern, and western brackenfern.

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, it is 105 for western hemlock and 118 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 207 cubic feet per acre per year, occurring at age 50. For Douglas fir, it is 163 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitation affecting timber harvesting is occasional snowpack. During an average year, the snowpack limits the use of equipment and restricts

access from January through March. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder and western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVe.

**154-Sorensen very gravelly silt loam, 30 to 60 percent slopes.** This very deep, well drained soil is on mountain back slopes and toe slopes. It formed in a mixture of volcanic ash, loess, and colluvium derived from glacial till. The till was derived from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 1,000 to 1,900 feet. The average annual precipitation is about 70 inches, the average annual air temperature is about 44 degrees F, and the average frost-free period is about 130 days.

Typically, the surface is covered with a mat of needles and twigs 4 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown very gravelly silt loam. The upper 6 inches of the subsoil is yellowish brown very gravelly loam. The lower 13 inches is light brownish gray very gravelly loam. The substratum to a depth of 60 inches is light olive gray very gravelly silt loam. In some areas the surface layer is very gravelly loam or gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is not dominated by phyllite rock fragments.

Included in this unit are small areas of Montborne, Rinker, and Skykomish soils and small areas of Sorensen soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Sorensen soil. Available water capacity is high. The effective rooting

depth is 60 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. Among the trees of limited extent are western redcedar, red alder, and bigleaf maple. The common understory plants are red huckleberry, western swordfern, and western brackenfern.

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, it is 105 for western hemlock and 118 for Douglas fir. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 207 cubic feet per acre per year, occurring at age 50. For Douglas fir, it is 163 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are occasional snowpack, the hazard of erosion, and the slope. During an average year, the snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by red alder and western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

**155-Springsteen very gravelly loam, 30 to 60 percent slopes.** This moderately deep, well drained soil is on high mountain back slopes. It formed in a mixture of volcanic ash, colluvium, and glacial till derived from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 1,800 to 2,600 feet. The average annual precipitation is about 80 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 105 days.

Typically, the surface is covered with a mat of leaves and twigs 5 inches thick. The surface layer is brown very gravelly loam 5 inches thick. The upper 8 inches of the subsoil is dark yellowish brown very gravelly loam. The lower 11 inches is dark brown very gravelly loam. Phyllite is at a depth of about 24 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is gravelly loam or very gravelly silt loam. In other areas the soil has more than 6 percent organic carbon in the upper part of the subsoil or is 40 to 60 inches deep to phyllite.

Included in this unit are small areas of Wollard and Kindy soils, soils that are 10 to 20 inches deep to phyllite, Rock outcrop, and Springsteen soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Springsteen soil. Available water capacity is low. The 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. Among the trees of limited extent are Pacific silver fir, Douglas fir, and western redcedar. The common understory plants are salmonberry, tall blue huckleberry, bunchberry dogwood, deer fern, salal, and western swordfern.

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, it is 96. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 213 cubic feet per acre per year, occurring at age 50.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from December through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the

available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Phyllite, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Soil creep is common on this unit. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

#### **156-Squalicum gravelly loam, 5 to 15 percent slopes.**

This deep, moderately well drained soil is on foothills and in valleys. It formed in a mixture of volcanic ash, loess, and slope alluvium over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 200 to 1,500 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 7 inches, the surface layer is very dark grayish brown gravelly loam. The subsoil is dark yellowish brown gravelly loam 23 inches thick. The substratum is light olive brown gravelly loam 14 inches thick. Dense glacial till that crushes to gravelly loam is at a depth of 44 inches. The depth to dense glacial till ranges from 40 to 60 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is loam or gravelly silt loam. In other areas the soil has a subsoil or substratum with 35 to 45 percent rock fragments, is more than 60 inches deep to dense glacial till or bedrock, is 40 to 60 inches deep over bedrock or sand and gravel, or has dominantly phyllite or sandstone rock fragments.

Included in this unit are small areas of Nati, Chuckanut, Squires, Blethen, Everett, and Whatcom soils, small areas of Bellingham and Labounty soils in depressions, soils that are similar to the Squalicum soil but have a clayey substratum, and Squalicum soils that

have slopes of more than 15 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Squalicum soil and very slow in the dense glacial till. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 3.5 to 5.0 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture and as a site for homes.

If this unit is used for hay and pasture, the main limitation is the hazard of erosion. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are Oregon grape, red huckleberry, western swordfern, vine maple, western brackenfern, salmonberry, and willow.

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, it is 132. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 187 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation affecting homesite development is the slope. The dense glacial till is rippable and,

therefore, is not a serious limitation for most engineering uses. The main limitations on sites for septic tank absorption fields are the seasonal high water table, the very slow permeability in the dense glacial till, and the slope. These limitations can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope.

This map unit is in capability subclass IIIe.

**157-Squalicum gravelly loam, 15 to 30 percent slopes.** This deep, moderately well drained soil is on foothills. It formed in a mixture of volcanic ash, loess, and slope alluvium over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 200 to 1,500 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 160 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 6 inches thick. The upper 10 inches of the subsoil is dark yellowish brown gravelly loam. The lower 27 inches is olive brown gravelly loam. Dense glacial till that crushes to gravelly sandy loam is at a depth of 43 inches. The depth to dense glacial till ranges from 40 to 60 inches. The dense glacial till is similar to a cemented pan. In some areas the surface is loam or gravelly silt loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil, is more than 60 inches deep to dense glacial till or bedrock, is 40 to 60 inches deep over bedrock or sand and gravel, or has dominantly phyllite or sandstone rock fragments.

Included in this unit are small areas of Nati, Chuckanut, Squires, Blethen, Everett, and Whatcom soils, small areas of Labounty soils in depressions, soils that are similar to the Squalicum soil but have a clayey substratum, and Squalicum soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Squalicum soil and very slow in the dense glacial till. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 3.5 to 5.0 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and

bigleaf maple. The common understory plants are Oregon grape, red huckleberry, western swordfern, vine maple, western brackenfern, salmonberry, and willow.

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, it is 132. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 187 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gully erosion unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVe.

**158-Squalicum gravelly loam, 30 to 60 percent slopes.** This deep, moderately well drained soil is on foothills. It formed in a mixture of volcanic ash, loess, and slope alluvium over glacial till. The native vegetation is mainly conifers and shrubs. Elevation is 200 to 1,500 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 160 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 6 inches thick. The upper 10 inches of the subsoil is dark yellowish brown gravelly loam. The lower 27 inches is olive brown gravelly loam. Dense glacial till that crushes to gravelly sandy loam is at a depth of 43 inches. The

depth to dense glacial till ranges from 40 to 60 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is loam or gravelly silt loam. In other areas the soil has 35 to 45 percent rock fragments in the subsoil, is more than 60 inches deep to dense glacial till or bedrock, is 40 to 60 inches deep over bedrock or sand and gravel, or has dominantly phyllite or sandstone rock fragments.

Included in this unit are small areas of Nati, Chuckanut, Squires, Blethen, Everett, and Whatcom soils, small areas of Labounty soils in depressions, soils that are similar to the Squalicum soil but have a clayey substratum, and Squalicum soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Squalicum soil and very slow in the dense glacial till. Available water capacity is moderate or high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 3.5 to 5.0 feet from December through April. Runoff is medium, and the hazard of water erosion is moderate. Water is perched above the dense glacial till from December through April.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are Oregon grape, red huckleberry, western swordfern, vine maple, western brackenfern, salmonberry, and willow.

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, it is 132. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 187 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of

compaction, puddling, and erosion.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

**159-Squalicum-Urban land complex, 5 to 20 percent slopes.** This map unit is on foothills. The native vegetation is mainly conifers and shrubs. Elevation is 200 to 600 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 50 percent Squalicum gravelly loam and 30 percent Urban land. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Chuckanut, Everett, Labounty, Sehome, and Whatcom soils and small areas of Squalicum soils that have slopes of more than 20 percent or less than 5 percent. Included areas make up about 20 percent of the total acreage.

The Squalicum soil is deep and moderately well drained. It formed in a mixture of volcanic ash, loess, and slope alluvium over glacial till. When mixed to a depth of 7 inches, the surface layer is very dark grayish brown gravelly loam. The subsoil is dark yellowish brown gravelly loam 23 inches thick. The substratum is light olive brown gravelly loam about 14 inches thick. Dense glacial till that crushes to gravelly loam is at a depth of 44 inches. The depth to dense glacial till ranges from 40 to 60 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is loam or gravelly silt loam. In other areas the soil has a subsoil or substratum with 35 to 45 percent rock fragments, is more than 60 inches deep to dense glacial till or bedrock, or is 40 to 60 inches deep over bedrock or sand and gravel.

Permeability is moderate in the upper part of the Squalicum soil and very slow in the dense glacial till. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 3.5 to 5.0 feet from December through April. Runoff is slow, and the hazard of water erosion is moderate.

The Urban land consists of areas covered by streets,

buildings, parking lots, and other structures that so obscure the soils that identification of the soil series is not feasible.

The Squalicum soil is used for lawns, gardens, parks, or vacant lots. It is highly erodible during construction and on cut and fill slopes.

If this unit is used for homesite development, the main limitation is the slope. Excavation for building sites is limited by the dense glacial till. The dense glacial till is rippable, however, and is not a serious limitation for most engineering uses.

The main limitation on sites for septic tank absorption fields is the seasonal high water table. This limitation can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour. The slope affects the installation of septic tank absorption fields. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope.

The Squalicum soil is in capability subclass IIIe. The Urban land is in capability subclass VIIIc.

**160-Squires very channery loam, 5 to 30 percent slopes.** This moderately deep, well drained soil is on back slopes, toe slopes, and foothills. It formed in a mixture of volcanic ash, loess, glacial till, and colluvium derived from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 1,400 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. When mixed to a depth of 5 inches, the surface layer is dark brown very channery loam. The upper 7 inches of the subsoil is dark brown very channery loam. The lower 6 inches is dark yellowish brown very channery loam. The substratum is light olive brown very channery sandy loam 12 inches thick. Phyllite is at a depth of about 30 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is channery loam, channery silt loam, or very channery silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Vanzandt, Heisler, Squalicum, and Sehome soils, soils that are less than 20 inches deep to phyllite or dense glacial till, stony areas, Rock outcrop, and Squires soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Squires soil.

Available water capacity also is moderate. The 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. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are western swordfern, western brackenfern, red huckleberry, salmonberry, vine maple, and Oregongrape.

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, it is 132. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 186 cubic feet per acre per year, occurring at age 60.

The kind of equipment that can be used and the time of the year when it can be used normally are not restricted on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Phyllite, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass IVe.

**161-Squires very channery loam, 30 to 60 percent slopes.** This moderately deep, well drained soil is on low mountain back slopes, toe slopes, and foothills. It formed in a mixture of volcanic ash, loess, glacial till, and colluvium derived from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 1,400 feet. The average annual precipitation is about 55 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface

layer is dark brown very channery loam 4 inches thick. The subsoil is dark brown very channery loam 14 inches thick. The substratum is olive brown extremely channery loam 14 inches thick. Phyllite is at a depth of about 32 inches. The depth to phyllite ranges from 20 to 40 inches. In some areas the surface layer is channery loam, channery silt loam, or very channery silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Vanzandt, Heisler, Squalicum, and Sehome soils, soils that are less than 20 inches deep to phyllite or dense glacial till, stony areas, Rock outcrop, and Squires soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Squires soil. Available water capacity also is moderate. The 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. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are western swordfern, western brackenfern, red huckleberry, salmonberry, vine maple, and Oregongrape.

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, it is 132. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 186 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Phyllite, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Soil creep is common on this unit.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting

timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the bedrock, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

#### **162-Sumas silt loam, drained, 0 to 2 percent slopes.**

This very deep, poorly drained soil is on flood plains. It has been artificially drained. It formed in recent alluvium. The native vegetation is mainly trees and shrubs. Elevation is 20 to 50 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark grayish brown silt loam 8 inches thick. The upper 18 inches of the underlying material is grayish brown, mottled silt loam. The lower part to a depth of 60 inches is very dark grayish brown, mottled sand. The depth to sand ranges from 14 to 36 inches. In some areas the surface layer is silty clay loam. In other areas the soil has a dark brown surface layer, has sandy loam or loam in the lower part of the underlying material, has 10 to 18 percent clay in the upper part of the underlying material, or is 36 to 60 inches deep to sand.

Included in this unit are small areas of Puget, Shalcar, and Briscot soils, undrained Sumas soils, and small bodies of water. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Sumas soil. Available water capacity is moderate. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 3 feet from November through April. Runoff is very slow, and there is no hazard of erosion. In most areas this soil is subject to occasional, brief periods of flooding from November through April. Downstream from Lynden, however, it is subject to frequent, brief periods of flooding from December through February.

This unit is used mainly for hay and pasture or as cropland. It also is used as woodland. The included undrained Sumas soils also are used as woodland.

The main limitations in the areas used as cropland are the high water table, the hazard of flooding, and the moderately slow permeability. This soil is well suited to most crops commonly grown in the survey area if adequate drainage systems are maintained. The

principal crops are peas, sweet corn, beans, and small grain. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Tile drains and field ditches should be maintained. They permit fieldwork to be conducted earlier in the spring and increase the yields of perennial crops. In summer, irrigation is required for maximum production.

The main limitations in the areas used for hay and pasture are the high water table, the hazard of flooding, and the moderately slow permeability. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. In areas where the drainage system is not maintained or in areas that do not have drainage, the water table limits the use of this unit to grasses. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, and black cottonwood. The common understory plants are salmonberry, Douglas spirea, rose, stinging nettle, and sedges.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the occasional flooding and the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The seasonal high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs

readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitations are the high water table and the hazard of flooding. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitations on sites for septic tank absorption fields are the high water table and the hazard of flooding.

This map unit is in capability subclass IIw.

**163-Tacoma silt loam, 0 to 1 percent slopes.** This very deep, very poorly drained soil is on flood plains, deltas, and tidal flats. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is sea level to 20 feet above sea level. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 185 days.

Typically, the surface layer is dark grayish brown, mottled silt loam 11 inches thick. The upper 7 inches of the underlying material is dark grayish brown, mottled silt loam. The next 30 inches is dark gray, mottled silt loam. The lower part to a depth of 60 inches is dark gray, mottled very fine sandy loam. In some areas the surface layer is very fine sandy loam. In other areas the soil has 18 to 35 percent clay in the upper part of the underlying material; is 30 to 40 inches deep to fine sandy loam or sand; or is stratified silt loam, sandy loam, and sand from 20 to 60 inches.

Included in this unit are small areas of drained Tacoma soils, organic soils in depressions subject to ponding, and small bodies of water. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Tacoma soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface from November through April. Runoff is very slow, and there is no hazard of erosion. This soil is subject to frequent, long periods of flooding from December through April. It is subject to tidal inundation unless protected.

This unit is used mainly as woodland or for wildlife habitat. Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, black cottonwood, and Sitka spruce.

The common understory plants are willow, western brackenfern, western swordfern, devilsclub, Indian plum, salmonberry, and Douglas spirea.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitations affecting timber harvesting are the muddiness caused by seasonal wetness and the hazard of flooding. These limit the use of equipment to dry periods. Unsurfaced roads are soft and slippery when wet and may be impassable during rainy periods. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, the hazard of windthrow, and plant competition are the main concerns affecting timber production. The high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong. The survival rate of seedlings may be low in areas where flooding occurs.

This map unit is in capability subclass VIw.

**164-Tacoma silt loam, drained, 0 to 1 percent slopes.** This very deep, very poorly drained soil is on flood plains, deltas, and tidal flats. It has been artificially drained. It formed in alluvium. The native vegetation is mainly trees and shrubs. Elevation is sea level to 20 feet above sea level. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 185 days.

Typically, the surface layer is dark grayish brown, mottled silt loam 7 inches thick. The upper 5 inches of the underlying material is dark grayish brown, mottled silt loam. The next 23 inches is dark gray, mottled silt

loam. The lower part to a depth of 60 inches is dark gray, mottled very fine sandy loam. In some areas the surface layer is very fine sandy loam. In other areas the soil has 18 to 35 percent clay in the upper part of the underlying material; is 30 to 40 inches deep to fine sandy loam or sand; or is stratified silt loam, sandy loam, and sand from 20 to 60 inches.

Included in this unit are small areas of undrained Tacoma soils and small areas of Shalcar soils, which are in depressions and are subject to ponding. Also included are small bodies of water. Included areas make up about 10 percent of the total acreage.

Permeability is moderately slow in the Tacoma soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.0 to 2.5 feet from November through April. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion. This soil is subject to frequent, brief periods of flooding from November through April. It is subject to tidal inundation unless protected.

This unit is used for hay and pasture or as cropland.

The main limitations in the areas used for hay and pasture are the high water table, the hazard of flooding, the moderately slow permeability, and the influence of salt. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. In areas where the drainage system is not maintained or in areas that do not have drainage, the water table limits the use of this unit to grasses and shallow-rooted legumes. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Field ditches, tile lines, and pumping stations are used to lower the water table and leach out salts. Using regulating structures in open ditches as a means of subirrigation can reduce the high acidity in the lower part of the underlying material.

The main limitations in the areas used as cropland are the high water table, the hazard of flooding, the moderately slow permeability, and the influence of salt. This soil is well suited to most crops commonly grown in the survey area if adequate drainage systems are maintained. The principal crops are peas, sweet corn, and small grain. Returning all crop residue to the soil and including grasses, legumes, or grass-legume mixtures in the cropping sequence help to maintain fertility and tilth. During the growing season, the water table is artificially lowered to a depth of about 3 to 5 feet. Tile drains and field ditches should be maintained. They permit fieldwork to be conducted earlier in the spring and increase the yields of perennial crops. Installing tile drains no deeper than 30 inches minimizes

the effects of the salt. Drainage tiles should be closely spaced because of the restricted permeability. In summer, irrigation is required for maximum production.

If this unit is used for homesite development, the main limitations are the high water table and the hazard of flooding. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the high water table, the moderately slow permeability, and the hazard of flooding. Installing absorption lines that are longer than normal helps to overcome these limitations.

This map unit is in capability subclass IIIw.

**165-Tromp loam, 0 to 2 percent slopes.** This very deep, moderately well drained soil is on outwash terraces. It formed in a mixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 300 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark brown loam 11 inches thick. The upper 9 inches of the subsoil is dark brown and strong brown loam. The lower 6 inches is weakly cemented, dark yellowish brown, mottled sandy loam. The upper 20 inches of the substratum is weakly cemented, olive brown, mottled sand. The lower part to a depth of 60 inches is grayish brown and dark grayish brown, mottled sand. The depth to sand ranges from 14 to 30 inches. In some areas the surface layer is sandy loam or silt loam. In other areas the soil is not cemented, is sandy loam in the upper part of the substratum, has 15 to 35 percent pebbles in the substratum, has loamy glaciomarine or glacial till at a depth of 40 to 60 inches, or is 10 to 14 inches deep to sand.

Included in this unit are small areas of Hale, Yelm, Edmonds, Lynden, Birchbay, and Whatcom soils and small areas of Tromp soils that are subject to occasional flooding. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Tromp soil and very rapid in the substratum. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 2.5 feet from November through April. Runoff is very slow, and there is no hazard of erosion.

This unit is used mainly for hay and pasture, as cropland, or as woodland. It also is used as a site for homes.

The main limitation in the areas used for hay and

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

This unit has few limitations in the areas used for cropland. The principal crops are raspberries, strawberries, and sweet corn. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, and western redcedar. The common understory plants are western swordfern, salal, Oregongrape, red huckleberry, vine maple, and western brackenfern.

On the basis of a 100-year site curve, the mean site index for Douglas fir is 129. On the basis of a 50-year site curve, it is 100. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 128 cubic feet per acre per year, occurring at age 70.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitation affecting homesite development is the seasonal high water table. The main limitations on sites for septic tank absorption fields are the seasonal high water table and a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to overcome these limitations.

This map unit is in capability subclass IIw.

**166-Twinsi very gravelly loam, 30 to 60 percent slopes.** This moderately deep, moderately well drained soil is on high mountain shoulder slopes and back slopes. It formed in colluvium and glacial till with an admixture of volcanic ash and loess. The colluvium and glacial till are derived from dunite. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 4,000 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles, twigs, and bark 8 inches thick. When mixed to a depth of 6 inches, the surface layer is strong brown very gravelly loam. The upper 8 inches of the subsoil is strong brown very gravelly loam. The lower 8 inches is dark yellowish brown very gravelly loam. The substratum is grayish brown very gravelly sandy loam 5 inches thick. Dense glacial till that crushes to very gravelly loam is at a depth of 27 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is very gravelly silt loam or gravelly loam. In other areas the soil is 40 to 60 inches deep to dense glacial till or dunite.

Included in this unit are small areas of Edfro, Jackman, and Klawatti soils, soils that are shallow over bedrock, Rock outcrop, and Twinsi soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Twinsi soil and very slow in the dense glacial till. Available water capacity is moderate. The 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 from November through April.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, Alaska cedar, and mountain hemlock. The common understory plants are tall blue huckleberry, bunchberry dogwood, western brackenfern, deer fern, and longtube twinflower. Vegetation is somewhat stunted and sparse because of the toxicity of the dunite-derived soil.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit.

Reforestation can be accomplished by planting western hemlock, Pacific silver fir, or Alaska cedar seedlings, which are adapted to the toxicity of dunite soils. If seed trees are available, natural reforestation of cutover areas by western hemlock, Pacific silver fir, and Alaska cedar occurs periodically. Trees grow poorly and lack vigor on soils that are derived from dunite. Planting seedlings in the organic layer improves growth and vigor. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**167-Twinsi very stony loam, 30 to 60 percent slopes.** This moderately deep, moderately well drained soil is on high mountain shoulder slopes and back slopes. It formed in colluvium and glacial till with an

admixture of volcanic ash and loess. The colluvium and glacial till are derived from dunite. The native vegetation is mainly conifers and shrubs. Elevation is 2,500 to 4,000 feet. The average annual precipitation is about 95 inches, the average annual air temperature is about 41 degrees F, and the average frost-free period is about 95 days.

Typically, the surface is covered with a mat of needles and twigs 6 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown very stony loam. The subsoil is strong brown extremely gravelly loam 19 inches thick. Dense glacial till that crushes to very gravelly sandy loam is at a depth of 25 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is very gravelly loam or very gravelly silt loam. In other areas the soil is 40 to 60 inches deep to dense glacial till or dunite.

Included in this unit are small areas of Edfro, Jackman, and Kiawatti soils, soils that are shallow over bedrock, Rock outcrop, and Twinsi soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Twinsi soil and very slow in the dense glacial till. Available water capacity is moderate. The 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 from November through April.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, Alaska cedar, and mountain hemlock. The common understory plants are tall blue huckleberry, bunchberry dogwood, western brackenfern, deer fern, and longtube twinflower. Vegetation is somewhat stunted and sparse because of the toxicity of the dunite-derived soil.

On the basis of a 100-year site curve, the mean site index for western hemlock is estimated to be 77. On the basis of a 50-year site curve, it is estimated to be 55. The highest average growth rate in unmanaged, even-aged stands of western hemlock is about 84 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, the surface stones, and the hazard of erosion. The trees can break if they are felled on the stones, and yarding operations can be hindered by the stones. During an average year, the snowpack limits the use of equipment and restricts access from November through May. When timber is harvested, the

slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality is the main concern affecting timber production. A high content of magnesium in relation to calcium, a high content of iron, a low concentration of other important minerals, and a low content of moisture in the surface layer during the growing season hinder the survival of planted and naturally established seedlings. A low soil temperature, deep snowpack, and a short growing season also hinder the survival of the seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit.

Reforestation can be accomplished by planting western hemlock, Pacific silver fir, or Alaska cedar seedlings, which are adapted to the toxicity of dunite soils. Because of the abundance of surface stones, planting seedlings by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock, Pacific silver fir, and Alaska cedar occurs periodically. Trees grow poorly and lack vigor on soils that are derived from dunite. Planting seedlings in the organic layer improves growth and vigor. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

#### **168-Typic Cryorthods, 60 to 90 percent slopes.**

These moderately deep to very deep, well drained soils are on high mountainsides and ridges. They formed in colluvium derived dominantly from glacial till, volcanic ash, and residuum from sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average annual precipitation is

about 85 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 100 days.

No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface is covered with a mat of needles, leaves, and twigs about 2 inches thick. When mixed to a depth of 9 inches, the surface layer is dark yellowish brown loam. The upper 26 inches of the subsoil is dark yellowish brown loam. The lower 11 inches is dark brown loam. The substratum to a depth of 60 inches is yellowish brown loam. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. The texture, the content of rock fragments, and the depth to dense glacial till or bedrock vary widely within short distances. Much of the unit is underlain by dense glacial till at a depth of more than 40 inches. The depth to bedrock is more than 20 inches. The content of rock fragments in the particle-size control section ranges from 0 to 30 percent by weighted average. The content of weathered rock fragments ranges from 25 to 60 percent by weighted average. The part of the profile having properties associated with weathered volcanic ash is 10 to more than 60 inches thick.

Included in this unit are small areas of Getchell, Potchub, Gallup, Saar, Crinker, and Hartnit soils, soils that are less than 20 inches deep over bedrock or dense glacial till, slumps, stony areas, Rock outcrop, and Typic Cryorthods that have slopes of less than 60 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Typic Cryorthods. Available water capacity is moderate or high. The effective rooting depth is more than 20 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, western redcedar, and mountain hemlock. The common understory plants are red huckleberry, blueleaved huckleberry, salal, longtube twinflower, salmonberry, and bunchberry dogwood.

On the basis of a 100-year site curve, the mean site index for western hemlock is 110. On the basis of a 50-year site curve, it is 78. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 160 cubic feet per acre per year, occurring at age 55. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, snowpack, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from November through April. Cable yarding systems generally are used on this

unit. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity.

Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is generally not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. The areas underlain by dense glacial till are most prone to landslides. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production.

Steep yarding paths, skid trails, and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. Because the rooting depth is restricted by the dense glacial till or bedrock in some areas, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

This map unit is in capability subclass VIIe.

**169-Typic Cryorthods-Rock outcrop complex, 60 to 90 percent slopes.** This map unit is on high mountainsides and ridges. The native vegetation is mainly conifers and shrubs. Elevation is 2,600 to 3,600 feet. The average annual precipitation is about 85 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 100 days.

This unit is 65 percent Typic Cryorthods and 20

percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Getchell, Potchub, Gallup, Saar, Crinker, and Hartnit soils, soils that are less than 20 inches deep over bedrock or dense glacial till, slumps, stony areas, and Typic Cryorthods that have slopes of less than 60 percent. Included areas make up about 15 percent of the total acreage.

The Typic Cryorthods are moderately deep to very deep and well drained. They formed in colluvium derived dominantly from glacial till, volcanic ash, and residuum from sandstone. No single profile is representative of these soils. In one of the more commonly observed ones, however, the surface is covered with a mat of needles, leaves, and twigs about 6 inches thick. When mixed to a depth of 6 inches, the surface layer is organic stained, dark yellowish brown loam. The subsoil is olive brown loam 18 inches thick. The substratum to a depth of 60 inches is light olive brown loam. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. The texture, the content of rock fragments, and the depth to dense glacial till or bedrock vary widely within short distances. Much of the unit is underlain by dense glacial till at a depth of more than 40 inches. The depth to bedrock is more than 20 inches. The content of rock fragments in the particle-size control section ranges from 0 to 30 percent by weighted average. The content of weathered rock fragments ranges from 25 to 60 percent by weighted average. The part of the profile having properties associated with weathered volcanic ash is 10 to more than 60 inches thick.

Permeability is moderate in the Typic Cryorthods. Available water capacity is moderate or high. The effective rooting depth is more than 20 inches. Runoff is rapid, and the hazard of water erosion is severe.

Typically, the Rock outcrop is sandstone or metasedimentary rock. It is hard and generally unweathered. It occurs as steep cliffs and irregular formations.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir, western redcedar, and mountain hemlock. The common understory plants are red huckleberry, blueleaved huckleberry, salal, longtube twinflower, salmonberry, and bunchberry dogwood.

On the basis of a 100-year site curve, the mean site index for western hemlock is 110. On the basis of a 50-year site curve, it is 78. The highest average growth rate in unmanaged, even-aged stands of western

hemlock is 160 cubic feet per acre per year, occurring at age 55. Yields are reduced by the extent of the Rock outcrop. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are the slope, the Rock outcrop, snowpack, and the hazard of erosion. The trees can break if they are felled on the Rock outcrop. During an average year, the snowpack limits the use of equipment and restricts access from November through April. The pattern of the Rock outcrop on the landscape results in a discontinuous slope, which hinders the use of cable yarding systems. These systems generally are used on this unit. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity.

Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is generally not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. The areas underlain by dense glacial till are most prone to landslides. Soil creep is common on this unit. Locating roads on midslopes requires extensive cutting and filling, which remove land from production.

Because of the Rock outcrop, yarding and skidding paths converge. This convergence results in compaction of the underlying soil. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gulying unless adequate water bars are provided or a protective plant cover is established. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling mortality and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. Because of the slope, planting by hand is difficult. If seed trees are

available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. The Rock outcrop prevents the even distribution of reforestation. Because the rooting depth is restricted by the dense glacial till and bedrock in some areas, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

The Typic Cryorthods are in capability subclass VIIe. The Rock outcrop is in capability subclass VIIIs.

**170-Typic Psammaquents, tidal, 0 to 1 percent slopes.** These very deep, poorly drained soils are on tidal flats. They formed in alluvium. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days. Elevation is sea level.

No single profile is representative of these soils. In one of the more commonly observed ones, however, the soil to a depth of 60 inches is gray and olive gray loamy sand and sand. The sand content ranges from 80 to 95 percent. The content of clay ranges from 0 to 2 percent. In some areas the soil has strata of sandy loam.

Included in this unit are small areas of water and Hydraquents. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the Typic Psammaquents. Available water capacity is low. The effective rooting depth is limited by a seasonal high water table, which is at or above the surface during periods of high tide. These soils are subject to frequent, long periods of flooding during high tides throughout the year.

This unit is used as wildlife habitat or for recreation.

This map unit is in capability subclass VIIIw.

**171-Urban land.** This map unit is on terraces. Slopes are 0 to 3 percent. Elevation is near sea level to 220 feet above sea level. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

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

Included in this unit are small areas of Labounty, Whatcom, Whitehorn, Birchbay, Everett, and Squalicum soils and small areas of Urban land that have slopes of more than 3 percent. Included areas make up about 10 percent of the total acreage.

This unit is used for urban development. This map unit is in capability subclass VIIIs.

**172-Urban land-Whatcom-Labounty complex, 0 to 8 percent slopes.** This map unit is on glaciomarine drift plains. The Whatcom soil is on 0 to 8 percent slopes, and the Labounty soil is on 0 to 2 percent slopes. The native vegetation is mainly trees and shrubs. Elevation is near sea level to 200 feet above sea level. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 40 percent Urban land, 30 percent Whatcom silt loam, and 20 percent Labounty silt loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Squalicum, Bellingham, Everett, Birchbay, Chuckanut, and Kickerville soils and small areas of Whatcom soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

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

The Whatcom soil is very deep and moderately well drained. It formed in a mixture of loess and volcanic ash over glaciomarine deposits. Typically, the surface layer is dark brown silt loam 9 inches thick. The upper 7 inches of the subsoil is dark brown silt loam. The lower 10 inches is light olive brown, mottled loam. The upper 9 inches of the substratum is olive gray, mottled loam. The lower part to a depth of 60 inches is dark gray loam. In some areas the surface layer is loam or gravelly silt loam. In other areas the substratum has lenses of sandy material, is 10 to 18 percent clay, or is 5 to 10 percent cobbles, stones, or boulders.

Permeability is moderate in the upper part of the Whatcom soil and slow in the lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 3.0 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

The Labounty soil is very deep and poorly drained. It formed in an admixture of loess, volcanic ash, and glaciomarine deposits. Typically, the surface layer is very dark grayish brown silt loam 10 inches thick. The upper 6 inches of the subsoil is grayish brown and light brownish gray, mottled loam. The lower 19 inches is grayish brown, olive gray, and light olive gray, mottled loam. The substratum to a depth of 60 inches is gray loam. In some areas the surface layer is loam. In other areas the substratum has lenses of sandy material, is 10 to 18 percent clay, or is 5 to 10 percent cobbles, stones, or boulders.

Permeability is moderately slow in the Labounty soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 3 feet from November through May. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion.

The Whatcom and Labounty soils in this unit are used for lawns, gardens, parks, or vacant lots.

The main limitation affecting homesite development is the high water table. Tile drains and open drains can be used to lower the water table if a suitable outlet is available. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The restricted permeability and the high water table increase the likelihood that the absorption field will fail. Installing absorption lines that are longer than normal helps to overcome these limitations.

The Urban land is in capability subclass VIII<sub>s</sub>. The Whatcom soil is in capability subclass II<sub>e</sub>. The Labounty soil is in capability subclass II<sub>w</sub>.

**173-Vanzandt very gravelly loam, 5 to 15 percent slopes.** This moderately deep, moderately well drained soil is on foothill toe slopes and in valleys. It formed in volcanic ash, loess, and slope alluvium over glacial till derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 250 to 1,500 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 1 inch thick. When mixed to a depth of 7 inches, the surface layer is dark brown very gravelly loam. The subsoil is dark yellowish brown and dark brown very gravelly loam 16 inches thick. The substratum is light yellowish brown, mottled very gravelly loam about 8 inches thick. Dense glacial till that crushes to very gravelly loam is at a depth of 31 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly loam or very gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and the upper part of the substratum or is 40 to 60 inches deep to dense glacial till.

Included in this unit are small areas of Squires, Heisler, and Barneston soils; Bellingham and Shalcar soils in depressions; soils that have a substratum of very gravelly sand; and Vanzandt soils that have slopes of more than 15 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Vanzandt soil and very slow in the dense glacial till. Available water capacity is moderate. The 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 from December through April.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common understory plants are Oregon grape, western swordfern, western brackenfern, vine maple, salal, red huckleberry, and salmonberry.

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, it is 125. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 169 cubic feet per acre per year, occurring at age 65.

The kind of equipment that can be used and the time of the year when it can be used normally are not restricted on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass IV<sub>e</sub>.

**174-Vanzandt very gravelly loam, 15 to 30 percent slopes.** This moderately deep, moderately well drained soil is on foothill back slopes and toe slopes. It formed in volcanic ash, loess, and slope alluvium over glacial till derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 250 to 1,500 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 8 inches, the surface layer is dark brown very gravelly loam. The subsoil is strong brown very gravelly loam 11 inches thick. The substratum is light

olive brown and grayish brown very gravelly loam 20 inches thick. Dense glacial till that crushes to very gravelly loam is at a depth of 39 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly loam or very gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and the upper part of the substratum or is 40 to 60 inches deep to dense glacial till.

Included in this unit are small areas of Squires, Heisler, and Barneston soils; Bellingham and Shalcar soils in depressions; soils that have a substratum of very gravelly sand; and Vanzandt soils that have slopes of more than 30 percent or less than 15 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Vanzandt soil and very slow in the dense glacial till. Available water capacity is moderate. The 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 from December through April.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common understory plants are Oregongrape, western swordfern, western brackenfern, vine maple, salal, red huckleberry, and salmonberry.

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, it is 125. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 169 cubic feet per acre per year, occurring at age 65.

The kind of equipment that can be used and the time of the year when it can be used normally are not restricted on this unit. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Steep skid trails and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass IVe.

**175-Vanzandt very gravelly loam, 30 to 60 percent slopes.** This moderately deep, moderately well drained soil is on low mountain back slopes and toe slopes. It formed in volcanic ash, loess, and slope alluvium over glacial till derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 250 to 1,500 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 2 inches thick. When mixed to a depth of 8 inches, the surface layer is dark brown very gravelly loam. The subsoil is strong brown very gravelly loam 11 inches thick. The substratum is light olive brown and grayish brown very gravelly loam 20 inches thick. Dense glacial till that crushes to very gravelly loam is at a depth of 39 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly loam or very gravelly silt loam. In other areas the soil has 15 to 35 percent rock fragments in the subsoil and the upper part of the substratum or is 40 to 60 inches deep to glacial till.

Included in this unit are small areas of Squires, Heisler, and Barneston soils; Bellingham and Shalcar soils in depressions; soils that have a substratum of very gravelly sand; and Vanzandt soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Vanzandt soil and very slow in the dense glacial till. Available water capacity is moderate. The 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 from December through April.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are Oregongrape, western swordfern, western brackenfern, vine maple, salal, red huckleberry, and salmonberry.

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, it is 134. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 186 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground reduce the hazard of erosion.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**176-Welcome loam, 5 to 30 percent slopes.** This deep, well drained soil is on mountain shoulder slopes and ridges. It formed in a mixture of volcanic ash, glacial till, colluvium, and slope alluvium derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 1,500 to 2,250 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 44 degrees F, and the average frost-free period is about 125 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark yellowish brown loam. The subsoil is dark yellowish brown loam 13 inches thick. The upper 8 inches of the substratum is light olive brown sandy loam. The lower part is light olive brown fine sandy loam. Sandstone is at a depth of 50 inches. The depth to sandstone ranges from 40 to 60 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is sandy loam or silt loam. In other areas the soil has a gravelly substratum or is more than 60 inches deep over bedrock.

Included in this unit are small areas of Oakes and Revel soils, stony areas, poorly drained soils in depressions, and Welcome soils that have slopes of more than 30 percent or less than 5 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Welcome soil. Available water capacity is moderate. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. Douglas fir and western hemlock are the main woodland species. Among the trees of limited extent are red alder and western redcedar. The common understory plants are red huckleberry, longtube twinflower, western swordfern, salal, and western brackenfern.

On the basis of a 100-year site curve, the mean site index is 135 for Douglas fir and is estimated to be 129 for western hemlock. On the basis of a 50-year site curve, it is 106 for Douglas fir and is estimated to be 89 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 139 cubic feet per acre per year, occurring at age 70. For western hemlock, it is about 198 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are occasional snowpack and the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. During an average year, the snowpack limits the use of equipment and restricts access from January through March. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling. Steep skid trails and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting

timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVe.

**177-Welcome loam, 30 to 60 percent slopes.** This deep, well drained soil is on mountain shoulder slopes and ridges. It formed in a mixture of volcanic ash, glacial till, colluvium, and slope alluvium derived dominantly from sandstone. The native vegetation is mainly conifers and shrubs. Elevation is 1,500 to 2,250 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 44 degrees F, and the average frost-free period is about 125 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 4 inches thick. When mixed to a depth of 6 inches, the surface layer is dark yellowish brown loam. The subsoil is dark yellowish brown loam 17 inches thick. The upper 12 inches of the substratum is olive brown sandy loam. The lower part is light olive brown sandy loam. Sandstone is at a depth of 52 inches. The depth to sandstone ranges from 40 to 60 inches. The content of weathered rock fragments ranges from 35 to 60 percent throughout this profile. In some areas the surface layer is sandy loam or silt loam. In other areas the soil has a gravelly substratum or is 40 to 60 inches deep over bedrock.

Included in this unit are small areas of Oakes and Revel soils, stony areas, poorly drained soils in depressions, Rock outcrop, and Welcome soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Welcome soil. Available water capacity is moderate. The 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. Among the trees of limited extent are red alder and western redcedar. The common understory plants are red huckleberry, northern twinflower, western swordfern, salal, and western brackenfern.

On the basis of a 100-year site curve, the mean site

index is 135 for Douglas fir and is estimated to be 129 for western hemlock. On the basis of a 50-year site curve, it is 106 for Douglas fir and is estimated to be 89 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 139 cubic feet per acre per year, occurring at age 70. For western hemlock, it is about 198 cubic feet per acre per year, occurring at age 50. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are occasional snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from January through March. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Sandstone, a poor-quality rock for road construction, is readily available. Cut and fill slopes tend to slump when wet. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established. A moderate reduction in productivity can be expected to result from unmanaged fires in undisturbed areas.

Seedling establishment is the main concern affecting timber production. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting Douglas fir or western hemlock seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock occurs readily and reforestation by Douglas fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass VIIe.

**178-Whatcom silt loam, 0 to 3 percent slopes.** This very deep, moderately well drained soil is in the higher areas of glaciomarine drift plains. It formed in a mixture of loess and volcanic ash over glaciomarine drift. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 600 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark brown silt loam 9 inches thick. The upper 7 inches of the subsoil is dark brown silt loam. The lower 10 inches is light olive brown, mottled loam. The upper 9 inches of the substratum is olive gray, mottled loam. The lower part to a depth of 60 inches is dark gray loam. In some areas the surface layer is loam or gravelly silt loam. In other areas the substratum has lenses of sandy material, is 10 to 18 percent clay, is 35 to 45 percent clay, or is 5 to 10 percent cobbles, stones, or boulders.

Included in this unit are small areas of Skipopa, Labounty, Bellingham, Birchbay, Laxton, Shalcar, and Whitehorn soils, somewhat poorly drained soils that are mottled at a depth of about 12 inches, and Whatcom soils that have slopes of more than 3 percent. Included areas make up about 25 percent of the total acreage.

Permeability is moderate in the upper part of the Whatcom soil and slow in the lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 3.0 feet from December through April. Runoff is very slow, and there is no hazard of erosion.

This unit is used mainly for hay and pasture. It also is used as woodland and as a site for homes.

Because of the nearly level slope, this soil remains saturated for longer periods than other Whatcom soils. This saturation delays the use of equipment, increases the hazard of puddling, and shortens the effective growing season unless the soil is drained.

The main limitations in the areas used for hay and pasture are the seasonal high water table and the slow permeability. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Some areas have been partially drained, which permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water. Most crops common to the

survey area can be grown if the drainage system is adequate.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, bigleaf maple, and paper birch. The common understory plants are vine maple, red huckleberry, salal, western swordfern, Oregon grape, western brackenfern, salmonberry, sweetscented bedstraw, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 154. On the basis of a 50-year site curve, it is estimated to be 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 163 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitation affecting homesite development is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the slow permeability and the high water table. Installing absorption lines that are longer than normal helps to overcome these limitations.

This map unit is in capability subclass IIw.

**179-Whatcom silt loam, 3 to 8 percent slopes.** This very deep, moderately well drained soil is in the higher areas of glaciomarine drift plains. It formed in a mixture of loess and volcanic ash over glaciomarine drift. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 600 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is dark brown silt loam 9 inches thick. The upper 7 inches of the subsoil is dark brown silt loam. The lower 10 inches is light olive brown, mottled loam. The upper 9 inches of the substratum is olive gray, mottled loam. The lower part to a depth of 60 inches is dark gray loam. In some areas the surface layer is loam or gravelly silt loam. In other areas the substratum has lenses of sandy material, is 10 to 18 percent clay, is 35 to 45 percent clay, or is 5 to 10 percent cobbles, stones, or boulders.

Included in this unit are small areas of Skipopa, Labounty, Bellingham, Birchbay, Laxton, Shalcar, and Whitehorn soils, somewhat poorly drained soils that are mottled at a depth of 12 inches, and Whatcom soils that have slopes of more than 8 percent or less than 3 percent. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the upper part of the Whatcom soil and slow in the lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 3.0 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture. It also is used as woodland and as a site for homes.

The main limitations in the areas used for hay and pasture are the seasonal high water table and the slow permeability in the substratum. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. Some areas have been partially drained, which permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. The wetness can be reduced in

some areas by diversions, which intercept water, and by open ditches, which remove excess water.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, bigleaf maple, and paper birch. The

common understory plants are vine maple, red huckleberry, salal, western swordfern, Oregongrape, western brackenfern, salmonberry, sweetscented bedstraw, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 154. On the basis of a 50-year site curve, it is estimated to be 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 163 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitation affecting homesite development is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the slow permeability and the high water table. Installing absorption lines that are longer than normal helps to overcome these limitations.

This map unit is in capability subclass IIe.

**180-Whatcom silt loam, 8 to 15 percent slopes.** This very deep, moderately well drained soil is in the higher areas of glaciomarine drift plains. It formed in a mixture of loess and volcanic ash over glaciomarine

drift. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 600 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 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 5 inches thick. The upper 14 inches of the subsoil is dark yellowish brown and yellowish brown silt loam. The lower 15 inches is yellowish brown and olive brown, mottled loam. The upper 9 inches of the substratum is light olive brown, mottled loam. The lower part to a depth of 60 inches is grayish brown, mottled loam. In some areas the surface layer is loam or gravelly silt loam. In other areas the substratum has lenses of sandy material, is 10 to 18 percent clay, or is 5 to 10 percent cobbles, stones, or boulders.

Included in this unit are small areas of Skipopa, Labounty, Bellingham, Birchbay, Laxton, Squalicum, Shalcar, and Whitehorn soils and small areas of Whatcom soils that have slopes of more than 15 percent or less than 8 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Whatcom soil and slow in the lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 3.0 feet from December through April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used for hay and pasture or as woodland. The main limitations in the areas used for hay and pasture are the seasonal high water table, the slope, and the hazard of erosion during periods of reestablishment. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer, poor tilth, and excessive runoff. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, bigleaf maple, and paper birch. The common understory plants are vine maple, red huckleberry, salal, western swordfern, Oregon grape, western brackenfern, salmonberry, sweetscented bedstraw, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 154. On the

basis of a 50-year site curve, it is estimated to be 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 163 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitation 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. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the seasonal high water table and the slow permeability in the substratum. These limitations can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour. The slope affects the installation of septic tank absorption fields. Effluent from absorption fields can surface in downslope areas and create a health hazard.

This map unit is in capability subclass IIIe.

#### **181-Whatcom silt loam, 30 to 60 percent slopes.**

This very deep, moderately well drained soil is on foothill back slopes. It formed in a mixture of loess and

volcanic ash over glaciomarine drift. The native vegetation is mainly conifers and shrubs. Elevation is 50 to 600 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 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 5 inches thick. The upper 14 inches of the subsoil is dark yellowish brown and yellowish brown silt loam. The lower 15 inches is yellowish brown and olive brown, mottled loam. The upper 9 inches of the substratum is light olive brown, mottled loam. The lower part to a depth of 60 inches is grayish brown, mottled loam. In some areas the surface layer is loam or gravelly silt loam. In other areas the substratum has lenses of sandy material, is 10 to 18 percent clay, is 35 to 45 percent clay, or is 5 to 10 percent cobbles, stones, or boulders.

Included in this unit are small areas of Laxton, Sehome, Squalicum, and Yelm soils, small areas of Bellingham and Shalcar soils on stream bottoms, and Whatcom soils that have slopes of less than 30 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the upper part of the Whatcom soil and slow in the lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 3.0 feet from December through April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, bigleaf maple, and paper birch. The common understory plants are vine maple, red huckleberry, salal, western swordfern, Oregongrape, western brackenfern, salmonberry, sweetscented bedstraw, and trailing blackberry.

On the basis of a 100-year site curve, the mean site index for Douglas fir is estimated to be 154. On the basis of a 50-year site curve, it is estimated to be 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 163 cubic feet per acre per year, occurring at age 60.

The main limitations affecting timber harvesting are the slope and the hazard of erosion. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use.

Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction, puddling, and erosion. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullyng unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**182-Whatcom-Labounty silt loams, 0 to 8 percent slopes.** This map unit is on glaciomarine drift plains that are hummocky. The Whatcom soil is on 0 to 8 percent slopes, and the Labounty soil is on 0 to 2 percent slopes. The native vegetation is mainly trees and shrubs. Elevation is 50 to 600 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 55 percent Whatcom silt loam and 25 percent Labounty silt loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Skipopa, Bellingham, and Shalcar soils, somewhat poorly drained soils that are mottled at a depth of about 12 inches, Labounty soils that have been artificially drained, and Whatcom soils that have slopes of more than 8 percent. Included areas make up about 20 percent of the total acreage.

The Whatcom soil is very deep and moderately well drained. It formed in a mixture of loess and volcanic ash over glaciomarine deposits. Typically, the surface layer is dark brown silt loam 9 inches thick. The upper 7

inches of the subsoil is dark brown silt loam. The lower 10 inches is light olive brown, mottled loam. The upper 9 inches of the substratum is light olive gray, mottled loam. The lower part to a depth of 60 inches is dark gray loam. In some areas the surface layer is loam or gravelly silt loam. In other areas the substratum has lenses of sandy material, is 10 to 18 percent clay, is 35 to 45 percent clay, or is 5 to 10 percent cobbles, stones, or boulders.

Permeability is moderate in the upper part of the Whatcom soil and slow in the lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 3.0 feet from December through April. Runoff is slow, and the hazard of water erosion is slight.

The Labounty soil is very deep and poorly drained. It formed in glaciomarine drift with an admixture of loess and volcanic ash. Typically, the surface layer is very dark grayish brown silt loam 10 inches thick. The upper 6 inches of the subsoil is grayish brown and light brownish gray, mottled loam. The lower 19 inches is grayish brown, olive gray, and light olive gray, mottled loam. The substratum to a depth of 60 inches is gray loam. In some areas the surface layer is loam. In other areas the soil has 10 to 18 percent or 35 to 45 percent clay in the subsoil and substratum, has lenses of sand in the substratum, or has 5 to 15 percent cobbles in the substratum.

Permeability is moderately slow in the Labounty soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface from November through May. Runoff generally is very slow, but the soil may be ponded during the winter. There is no hazard of erosion. Runoff from the higher areas of the microrelief increases the poorly drained conditions in the depressions.

This unit is used mainly for hay and pasture. It also is used as woodland and as a site for homes.

The main limitations in the areas used for hay and pasture are the high water table and the slow permeability in the substratum of the Whatcom soil. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soils are wet results in compaction of the surface layer and poor tilth. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

Tile drains and field ditches are needed to lower the high water table if deep-rooted plants are to be grown. Some areas have been partially drained, which permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. The wetness

can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water. The depressions in this unit generally are not connected and cannot be easily drained.

Douglas fir and red alder are the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, bigleaf maple, and paper birch. The common understory plants are red huckleberry, salal, western swordfern, Oregon grape, western brackenfern, salmonberry, Douglas spirea, sweetscented bedstraw, trailing blackberry, and skunkcabbage.

On the basis of a 100-year site curve, the mean site index for Douglas fir on the Whatcom soil is estimated to be 154. On the basis of a 50-year site curve, it is estimated to be 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 163 cubic feet per acre per year, occurring at age 60.

On the basis of a 50-year site curve, the mean site index for red alder on the Labounty soil is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The high water table hinders root respiration and thus results in a low seedling survival rate on the Labounty soil. Reforestation can be accomplished by planting Douglas fir, western redcedar, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are occasionally

subject to windthrow when the soils are wet and winds are strong.

If this unit is used for homesite development, the main limitation is the high water table. Tile drains and open drains can be used to lower the water table if a suitable outlet is available. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the high water table and the slow permeability in the substratum of the Whatcom soil. Installing the absorption field in fill approved by the health district helps to overcome these limitations.

The Whatcom soil is in capability subclass IIe. The Labounty soil is in capability subclass VIw.

**183-Whatcom-Labounty silt loams, 0 to 15 percent slopes.** This map unit is on glaciomarine drift plains that are hummocky. The Whatcom soil is on 8 to 15 percent slopes, and the Labounty soil is on 0 to 2 percent slopes. The native vegetation is mainly trees and shrubs. Elevation is 50 to 600 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 55 percent Whatcom silt loam and 25 percent Labounty silt loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Skipopa, Bellingham, and Shalcar soils, somewhat poorly drained soils that are mottled at a depth of about 12 inches, Labounty soils that have been artificially drained, and Whatcom soils that have slopes of more than 15 percent. Included areas make up about 20 percent of the total acreage.

The Whatcom soil is very deep and moderately well drained. It formed in a mixture of loess and volcanic ash over glaciomarine deposits. Typically, the surface layer is dark brown silt loam 9 inches thick. The upper 7 inches of the subsoil is dark brown silt loam. The lower 10 inches is light olive brown, mottled loam. The upper 9 inches of the substratum is olive gray, mottled loam. The lower part to a depth of 60 inches is dark gray loam. In some areas the surface layer is loam or gravelly silt loam. In other areas the substratum has lenses of sandy material, is 10 to 18 percent clay, is 35 to 45 percent clay, or is 5 to 10 percent cobbles, stones, or boulders.

Permeability is moderate in the upper part of the Whatcom soil and slow in the lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a

depth of 1.5 to 3.0 feet from December through April. Runoff is medium, and the hazard of water erosion is moderate.

The Labounty soil is very deep and poorly drained. It formed in glaciomarine drift with an admixture of loess and volcanic ash. Typically, the surface layer is very dark grayish brown silt loam 10 inches thick. The upper 6 inches of the subsoil is grayish brown and light brownish gray, mottled loam. The lower 19 inches is grayish brown, olive gray, and light olive gray, mottled loam. The substratum to a depth of 60 inches is gray loam. In some areas the surface layer is loam. In other areas the soil has 10 to 18 percent or 35 to 45 percent clay in the subsoil and substratum or has lenses of sand in the substratum.

Permeability is moderately slow in the Labounty soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface from November through May. Runoff generally is very slow, but the soil may be ponded during the winter. There is no hazard of erosion. Runoff from the higher areas of the microrelief increases the poorly drained conditions in the depressions.

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

The main limitations in the areas used for hay and pasture are the high water table and the slow permeability in the substratum of the Whatcom soil. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soils are wet results in compaction of the surface layer, poor tilth, and excessive runoff. The wetness limits the choice of plants and the period of cutting or grazing and increases the risk of winterkill.

Tile drains and field ditches are needed to lower the high water table if deep-rooted plants are, to be grown. Some areas have been partially drained, which permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water. The depressions in this unit generally are not connected and cannot be easily drained.

Douglas fir and red alder are the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, bigleaf maple, and paper birch. The common understory plants are red huckleberry, salal, western swordfern, Oregongrape, western brackenfern, salmonberry, Douglas spirea, sweetscented bedstraw, trailing blackberry, and skunkcabbage.

On the basis of a 100-year site curve, the mean site

index for Douglas fir on the Whatcom soil is estimated to be 154. On the basis of a 50-year site curve, it is estimated to be 116. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 163 cubic feet per acre per year, occurring at age 60.

On the basis of a 50-year site curve, the mean site index for red alder on the Labounty soil is estimated to be 90. The highest average growth rate in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soils are wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soils. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The high water table hinders root respiration and thus results in a low seedling survival rate on the Labounty soil. Reforestation can be accomplished by planting Douglas fir, western redcedar, or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are occasionally subject to windthrow when the soils are wet and winds are strong.

If this unit is used for homesite development, the main limitation is the high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the high water table and the slow permeability in the substratum of the Whatcom soil. These limitations can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the

contour. The slope affects the installation of septic tank absorption fields on the Whatcom soil. During the rainy season, the effluent from onsite sewage disposal systems can seep at points downslope.

The Whatcom soil is in capability subclass IIIe. The Labounty soil is in capability subclass VIw.

**184-Whitehorn silt loam, 0 to 2 percent slopes.** This very deep, poorly drained soil is on wave-reworked glaciomarine drift plains. It formed in volcanic ash, loess, glaciofluvial deposits, and glaciomarine drift. The native vegetation is mainly trees and shrubs. Elevation is 50 to 350 feet. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 180 days.

Typically, the surface layer is very dark brown silt loam 10 inches thick. The upper 8 inches of the subsoil is dark brown, light olive brown, and dark grayish brown, mottled loam and very fine sandy loam. The lower 8 inches is grayish brown and dark brown, mottled very gravelly sandy loam. The upper 7 inches of the substratum is olive brown and grayish brown, mottled loam. The lower part to a depth of 60 inches is olive brown and brown, mottled silt loam. The depth to very gravelly sandy loam ranges from 16 to 24 inches. In some areas the surface layer is loam. In other areas the soil is sandy textured in the lower part of the subsoil, has lenses of sandy material in the substratum, has 10 to 18 percent clay in the substratum, has 15 to 35 percent pebbles in the lower part of the substratum, or is 40 to 60 inches deep to the substratum.

Included in this unit are small areas of Labounty, Birchbay, Clipper, Bellingham, and Hale soils, small areas of Shalcar soils in depressions, and drained Whitehorn soils. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the Whitehorn soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at or near the surface from November through May. Runoff generally is very slow, but the soil may be ponded during the winter and spring. There is no hazard of erosion.

This unit is used for hay and pasture, as cropland, or as woodland. The main concerns in the areas used for hay and pasture are the high water table and hazards of compaction and puddling. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. The water table limits the use of this unit to grasses unless a drainage system is installed. The wetness limits the choice of plants and

the period of cutting or grazing and increases the risk of winterkill.

The main limitation in the areas used as cropland is the high water table. The principal crop is corn silage. This unit also is suited to other climatically adapted crops. Some areas have been partially drained, which permits fieldwork to be conducted earlier in the spring and increases the yields of perennial crops. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water.

Red alder is the main woodland species. Among the trees of limited extent are western redcedar, western hemlock, Douglas fir, and black cottonwood. The common understory plants are salmonberry, western brackenfern, trailing blackberry, skunkcabbage, sweetscented bedstraw, red huckleberry, and western swordfern.

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 in unmanaged, even-aged stands of red alder is about 101 cubic feet per acre per year, occurring at age 40.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft when wet and may be impassable during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment, seedling mortality, and the hazard of windthrow are the main concerns affecting timber production. The high water table hinders root respiration and thus results in a low seedling survival rate. Reforestation can be accomplished by planting red alder or western redcedar seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the high water table, trees are frequently subject to windthrow when the soil is wet and winds are strong.

If this unit is used for homesite development, the main limitation is the high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitations on sites for septic tank absorption fields are the slow permeability and the high water table. Installing the absorption field in fill approved by the health district helps to overcome these limitations.

This map unit is in capability subclass VIw.

**185-Wickersham channery silt loam, 0 to 8 percent slopes.** This very deep, well drained soil is on alluvial fans and terraces. It formed in alluvium derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 250 to 350 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 170 days.

Typically, the surface layer is very dark gray and dark gray channery silt loam 12 inches thick. The subsoil is grayish brown silt loam 9 inches thick. The substratum to a depth of 60 inches is dark gray extremely channery loamy sand and very channery loamy sand. Depth to the extremely channery loamy sand and very channery loamy sand ranges from 15 to 30 inches. In some areas the surface layer is silt loam or loam. In other areas the soil has strata of channery sandy loam or very channery sandy loam in the substratum, has 35 to 50 percent rock fragments in the subsoil, or is 30 to 40 inches deep to the substratum.

Included in this unit are small areas of Wiseman and Barneston soils, poorly drained alluvial soils, and Wickersham soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Wickersham soil and very rapid in the lower part. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare flooding.

This unit is used for hay and pasture, as woodland, and as a site for homes. It has few limitations when used for hay and pasture. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, paper birch, western redcedar, western hemlock, and bigleaf maple. The common understory plants are elderberry, salmonberry, vine maple, and rose.

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, it is estimated to be 130. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 182 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation affecting homesite development is the hazard of flooding. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum.

This map unit is in capability subclass IIIe.

**186-Winston silt loam, 0 to 3 percent slopes.** This very deep, well drained soil is on outwash terraces. It formed in a mixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 900 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. When mixed to a depth of 6 inches, the surface layer is dark brown silt loam. The upper 5 inches of the subsoil is dark brown loam. The lower 8 inches is dark yellowish brown gravelly loam. The upper 6 inches of the substratum is dark yellowish brown very gravelly loamy sand. The

lower part to a depth of 60 inches is very dark grayish brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 14 to 30 inches. In some areas the surface layer is loam or gravelly silt loam. In other areas the substratum is very gravelly sandy loam or has 15 to 35 percent rock fragments.

Included in this unit are small areas of Barneston, Blethen, and Clipper soils; soils that are less than 14 inches deep to extremely gravelly sand; Bellingham and Shalcar soils in depressions; and Winston soils that have slopes of more than 3 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Winston soil and very rapid in the lower part. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is very slow, and there is no hazard of water erosion.

This unit is used for hay and pasture, as woodland, and as a site for homes. The main limitation in the areas used for hay and pasture is the moderate available water capacity. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are salal, Oregon grape, western brackenfern, western swordfern, vine maple, and red huckleberry.

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, it is 125 for Douglas fir and 114 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 174 cubic feet per acre per year, occurring at age 60. For western hemlock, it is 258 cubic feet per acre per year, occurring at age 50. Severe ice-laden winds from the northeast cause damage to trees in winter and reduce yields accordingly.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and

using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This unit has few limitations in the areas used for homesite development. In shallow excavations retainer walls may be needed to keep cutbanks from caving. If used as a base for roads and streets, the soil can be mixed with the underlying sand and gravel, which can increase the strength and stability of the soil. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to overcome this limitation.

This map unit is in capability subclass IIs.

**187-Winston loam, 3 to 15 percent slopes.** This very deep, well drained soil is on outwash terraces. It formed in a mixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 900 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark reddish brown loam 8 inches thick. The subsoil is dark reddish brown gravelly loam 11 inches thick. The substratum to a depth of 60 inches is dark yellowish brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 14 to 30 inches. In some areas the surface layer is silt loam or gravelly loam. In other areas the substratum is very gravelly sandy loam or has 15 to 35 percent rock fragments.

Included in this unit are small areas of Barneston, Blethen, and Clipper soils; soils that are less than 14 inches deep to extremely gravelly sand; Bellingham and Shalcar soils in depressions; and Winston soils that have slopes of more than 15 percent or less than 3 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Winston soil and very rapid in the lower part. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It also is used for hay and pasture and as a site for homes.

The main limitations in the areas used for hay and pasture are the hazards of compaction and erosion during periods of reestablishment and the moderate available water capacity. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, red alder, western redcedar, and bigleaf maple. The common understory plants are salal, Oregongrape, western brackenfern, western swordfern, vine maple, and red huckleberry.

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, it is 125 for Douglas fir and 114 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 174 cubic feet per acre per year, occurring at age 60. For western hemlock, it is 258 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are readily available.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation affecting homesite development is the slope. If used as a base for roads and streets, the soil can be mixed with the underlying sand and gravel, which can increase the strength and stability of the soil. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. The

slope affects the installation of septic tank absorption fields. The absorption lines should be installed on the contour.

This map unit is in capability subclass IIIe.

**188-Winston loam, 15 to 40 percent slopes.** This very deep, well drained soil is on outwash terraces. It formed in a mixture of loess and volcanic ash over glacial outwash. The native vegetation is mainly conifers and shrubs. Elevation is 300 to 900 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 160 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 3 inches thick. The surface layer is dark reddish brown loam 8 inches thick. The subsoil is dark reddish brown gravelly loam 11 inches thick. The substratum to a depth of 60 inches is dark yellowish brown extremely gravelly sand. The depth to extremely gravelly sand ranges from 14 to 30 inches. In some areas the substratum is very gravelly sandy loam or has 15 to 35 percent rock fragments.

Included in this unit are small areas of Barneston, Blethen, and Clipper soils; soils that are less than 14 inches deep to extremely gravelly sand; Bellingham and Shalcar soils in depressions; and Winston soils that have slopes of more than 40 percent or less than 15 percent. Included areas make up about 10 percent of the total acreage.

Permeability is moderate in the upper part of the Winston soil and very rapid in the lower part. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is slow or medium, and the hazard of water erosion is severe.

This unit is used as woodland. Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western hemlock, western redcedar, and bigleaf maple. The common understory plants are salal, Oregongrape, western brackenfern, western swordfern, vine maple, and red huckleberry.

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, it is 125 for Douglas fir and 114 for western hemlock. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is 174 cubic feet per acre per year, occurring at age 60. For western hemlock, it is 258 cubic feet per acre per year, occurring at age 50.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. The use of wheeled and tracked equipment during periods when the soil is wet causes excessive rutting. Using low-pressure ground equipment can minimize damage to

the soil. Logging roads require suitable surfacing for year-round use. Rounded pebbles for road construction are readily available. Cut and fill slopes tend to ravel when dry.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a high degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction, puddling, and erosion. Steep skid trails and firebreaks are subject to rifling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily and reforestation by western hemlock occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

This map unit is in capability subclass IVe.

**189-Wiseman very channery sandy loam, 0 to 8 percent slopes.** This very deep, somewhat excessively drained soil is on alluvial fans. It formed in alluvium derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 250 to 350 feet. The average annual precipitation is about 60 inches, the average annual air temperature is about 48 degrees F, and the average frost-free period is about 170 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs 6 inches thick. When mixed to a depth of 7 inches, the surface layer is dark brown very channery sandy loam. The upper 13 inches of the substratum is dark yellowish brown very channery loamy sand. The lower part to a depth of 60 inches is grayish brown, dark grayish brown, and dark yellowish brown very channery sand. The depth to very channery sand or very channery loamy sand ranges from 2 to 8 inches. In some areas the surface layer is channery loam or channery sandy loam. In other areas the soil is very channery sandy loam in the upper part of the substratum.

Included in this unit are small areas of Wickersham and Barneston soils and areas of Wiseman soils that have slopes of more than 8 percent. Included areas make up about 10 percent of the total acreage.

Permeability is very rapid in the Wiseman soil. Available water capacity is low. The effective rooting

depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare flooding.

This unit is used as woodland, for hay and pasture, and as a site for homes. The main limitation in the areas used for hay and pasture is the low available water capacity. Proper stocking rates, pasture rotation, and restricted grazing during short wet periods help to keep the pasture in good condition and help to control runoff and erosion. In summer, irrigation is required for maximum production.

Douglas fir is the main woodland species. Among the trees of limited extent are western hemlock, western redcedar, red alder, and bigleaf maple. The common understory plants are western swordfern, western brackenfern, vine maple, and salmonberry.

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, it is estimated to be 115. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 161 cubic feet per acre per year, occurring at age 60.

The kind of equipment that can be used and the time of year when it can be used normally are not restricted on this unit. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available.

Equipment and logs on the surface result in a moderate degree of soil displacement when the soil is dry. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of displacement.

Seedling establishment is the main concern affecting timber production. A low content of moisture in the surface layer during the growing season hinders the survival of planted or naturally established seedlings. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means.

The main limitation affecting homesite development is the hazard of flooding. In shallow excavations special retainer walls may be needed to keep cutbanks from caving. The main limitation on sites for septic tank absorption fields is a poor filtering capacity in the substratum. Installing the absorption field in fill approved by the health district helps to overcome this limitation.

This map unit is in capability subclass IVs.

#### **190-Wollard gravelly silt loam, 30 to 60 percent**

**slopes.** This moderately deep, moderately well drained soil is on mountain back slopes. It formed in a mixture of volcanic ash, colluvium, and slope alluvium over glacial till derived dominantly from phyllite. The native vegetation is mainly conifers and shrubs. Elevation is 2,200 to 3,100 feet. The average annual precipitation is about 75 inches, the average annual air temperature is about 42 degrees F, and the average frost-free period is about 105 days.

Typically, the surface is covered with a mat of needles and twigs 5 inches thick. When mixed to a depth of 5 inches, the surface layer is yellowish brown gravelly silt loam. The upper 4 inches of the subsoil is yellowish brown gravelly silt loam. The lower 21 inches is light brownish gray gravelly loam. Dense glacial till that crushes to gravelly loam is at a depth of 30 inches. The depth to dense glacial till ranges from 20 to 40 inches. The dense glacial till is similar to a cemented pan. In some areas the surface layer is gravelly loam or silt loam. In other areas the soil has 35 to 50 percent rock fragments in the subsoil or substratum, is 40 to 60 inches deep to dense glacial till, has more than 6 percent organic carbon in the upper part of the subsoil, or has rock fragments that are not dominantly phyllite.

Included in this unit are small areas of Crinker and Springsteen soils, soils that are less than 20 inches deep to dense glacial till, Rock outcrop, and Wollard soils that have slopes of more than 60 percent or less than 30 percent. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability is moderate in the upper part of the Wollard soil and very slow in the dense glacial till. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Water is perched above the dense glacial till from November through April. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland. Western hemlock is the main woodland species. Among the trees of limited extent are Pacific silver fir and western redcedar. The common understory plants are bunchberry dogwood, deer fern, salmonberry, tall blue huckleberry, and trailing blackberry.

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, it is 98. The highest average growth rate in unmanaged, even-aged stands of western hemlock is 216 cubic feet per acre per year, occurring at age 60. Areas on ridgetops that are subject to strong, persistent winds are less productive than the other areas of this unit.

The main limitations affecting timber harvesting are snowpack, the slope, and the hazard of erosion. During an average year, the snowpack limits the use of equipment and restricts access from December through April. When timber is harvested, the slope restricts the use of wheeled and tracked skidding equipment. Cable yarding systems generally are safer and disturb the surface less extensively. Because most of the roots are concentrated in the organic mat, loss of this layer during logging greatly reduces natural fertility and the available water capacity. Unsurfaced roads are soft and slippery when wet and are subject to deep rutting during rainy periods. Rock for road construction is not readily available. Cut and fill slopes tend to slump when wet. Following road construction and clearcutting, road failures and landslides are likely. Soil creep is common on this unit.

Equipment and logs on the surface result in a moderate degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and cable yarding paths, properly timing their use, and using cable systems that lift logs entirely off the ground can reduce the degree of compaction and puddling. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless adequate water bars are provided or a protective plant cover is established.

Seedling mortality, seedling establishment, and the hazard of windthrow are the main concerns affecting timber production. A low soil temperature, deep snowpack, and a short growing season hinder the survival of planted and natural seedlings and delay their establishment. The seedling mortality rate is higher on ridgetops that are subject to strong, persistent winds than in other areas of this unit. Reforestation can be accomplished by planting western hemlock or Pacific silver fir seedlings. If seed trees are available, natural reforestation of cutover areas by western hemlock and Pacific silver fir occurs periodically. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can delay the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the dense glacial till, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

This map unit is in capability subclass VIIe.

**191-Yelm loam, 3 to 8 percent slopes.** This very deep, moderately well drained soil is on terraces. It formed in a mixture of loess and volcanic ash over glaciofluvial deposits. The native vegetation is mainly conifers and shrubs. Elevation is 50 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 period is about 170 days.

Typically, the surface layer is dark brown loam 8 inches thick. The upper 22 inches of the subsoil is dark brown and dark yellowish brown loam. The lower 6 inches is dark yellowish brown and yellowish brown, mottled loam. The upper 14 inches of the substratum is light brownish gray and pale brown, mottled very fine sandy loam. The lower part to a depth of 60 inches is light gray and light olive brown, mottled very fine sandy loam. In some areas the surface layer is silt loam or fine sandy loam. In other areas the soil is 40 to 60 inches deep to sand or clay loam.

Included in this unit are small areas of Laxton, Tromp, Whatcom, and Whitehorn soils and areas of Yelm soils that have slopes of more than 8 percent or less than 3 percent. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the Yelm soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 3.0 feet from December through March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture. It also is used as woodland and as a site for homes.

The main limitation in the areas used for hay and pasture is the seasonal high water table. Proper stocking rates, pasture rotation, and restricted grazing during wet periods help to keep the pasture in good condition. Grazing when the soil is wet results in compaction of the surface layer and poor tilth. Some areas have been partially drained, mainly by open ditches, but adequate drainage systems have not been maintained. The wetness can be reduced in some areas by diversions, which intercept water, and by open ditches, which remove excess water.

Douglas fir is the main woodland species. Among the trees of limited extent are red alder, western redcedar, and bigleaf maple. The common understory plants are salal, red huckleberry, Oregon grape, western brackenfern, western swordfern, trailing blackberry, salmonberry, and vine maple.

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, it is estimated to be 130. The highest average growth rate in unmanaged, even-aged stands of Douglas fir is about 184 cubic feet per acre per year, occurring at age 60.

The main limitation affecting timber harvesting is the muddiness caused by seasonal wetness. This limits the use of equipment to dry periods. The use of wheeled and tracked equipment when the soil is wet causes excessive rutting. Using low-pressure ground equipment

can minimize damage to the soil. Unsurfaced roads are soft when wet and are subject to deep rutting during rainy periods. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Extra rock is needed to maintain a stable, uniform road surface.

Equipment and logs on the surface result in a high degree of compaction when the soil is moist and a moderate degree of puddling when the soil is wet. Carefully laying out roads and skid trails, properly timing their use, and using low-pressure ground equipment can reduce the degree of compaction and puddling.

Seedling establishment is the main concern affecting timber production. Reforestation can be accomplished by planting Douglas fir or red alder seedlings. If seed trees are available, natural reforestation of cutover areas by red alder occurs readily. When openings are made in the canopy, the uncontrolled invasion and growth of competing plants can prevent the establishment of seedlings. Competing vegetation can be controlled by mechanical or chemical means. Because the rooting depth is restricted by the seasonal high water table, trees are occasionally subject to windthrow when the soil is wet and winds are strong.

The main limitation affecting homesite development is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitation on sites for septic tank absorption fields is the seasonal high water table. This limitation can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour.

This map unit is in capability subclasses IIe, nonirrigated, and IIIe, irrigated.

#### **192-Yelm-Urban land complex, 0 to 3 percent slopes.**

This map unit is on terraces. The native vegetation is mainly conifers and shrubs. Elevation is near sea level to 150 feet above sea level. The average annual precipitation is about 35 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 170 days.

This unit is 50 percent Yelm loam and 30 percent Urban land. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the selected scale of mapping.

Included in this unit are small areas of Laxton, Tromp, Whatcom, and Whitehorn soils and areas of Yelm soils that have slopes of more than 3 percent. Included areas make up about 20 percent of the total acreage.

The Yelm soil is very deep and moderately well

drained. It formed in a mixture of loess and volcanic ash over glaciofluvial deposits. Typically, the surface layer is dark brown loam 8 inches thick. The upper 22 inches of the subsoil is dark brown and dark yellowish brown loam. The lower 6 inches is dark yellowish brown and yellowish brown, mottled loam. The upper 14 inches of the substratum is light brownish gray and pale brown, mottled very fine sandy loam. The lower part to a depth of 60 inches is light gray and light olive brown, mottled very fine sandy loam. In some areas the surface layer is silt loam or fine sandy loam.

Permeability is moderately rapid in the Yelm soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 3.0 feet from December through March. Runoff is very slow, and there is no hazard of erosion.

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

The Yelm soil is used for lawns, gardens, parks, or vacant lots.

If this unit is used for homesite development, the main limitation is the seasonal high water table. The wetness can be reduced by building the house on a pad and by installing drainage tile around footings if a suitable outlet is available. The main limitation on sites for septic tank absorption fields is the seasonal high water table. This limitation can be overcome by using interceptor drains, by installing the absorption field at a shallow depth, and by installing absorption lines that are longer than normal and that are on the contour.

The Yelm soil is in capability subclass IIw. The Urban land is in capability subclass VIIIs.

## **Prime Farmland**

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those

crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 8 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 67,000 acres, or 13 percent of the survey area, all in the western part, meets the requirements for prime farmland without drainage measures, flood control, or irrigation. In addition, 65,000 acres, or nearly 13 percent, mostly in general soil map units 5, 6, 7, and 8, meets the requirements for prime farmland where the soils are drained; 17,000 acres, or 3 percent, all in general soil map unit 1, is prime farmland where the soils are protected from flooding or are not frequently flooded; 15,000 acres, or nearly 3 percent, mostly in

general soil map units 4 and 5, is prime farmland where the soils are irrigated; and 18,000 acres, or about 4 percent, all in general map unit 3, is prime farmland where the soils are drained and protected from flooding.

A recent trend in land use in some parts of the survey area has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Soils that have limitations, such as a seasonal high water table, frequent flooding during the growing season, or inadequate rainfall, qualify for prime farmland only in areas where these limitations have been overcome by such measures as drainage, flood control, or irrigation. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures.

# Use and Management of the Soils

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This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as 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 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 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

Prepared by John A. Gillies, district conservationist, Soil Conservation Service.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly

grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Approximately 288,000 acres in the survey area is in capability classes II, III, and IV. About 81,000 acres in Whatcom County is used as cropland and about 23,500 acres as pasture. The primary cash crops are red raspberries, potatoes, sweet peas, carrots, and small grain. The primary forage crops are corn and grass silage. The county leads the state in the production of dairy products, red raspberries, and seed potatoes. There are about 500 dairy producers and 1,445 full- and part-time farmers in the county. The farms operated by full-time farmers average about 120 acres in size, and the ones operated by part-time farmers average about 45 acres.

The drainage class and fertility level of the soils in the survey area vary widely. About 38,585 acres on the broad flood plains along the Nooksack River is intensively used for agricultural purposes. On 62,685 acres the soils formed in glacial outwash, and on about 12,955 acres the soils used for agricultural purposes formed in organic material.

The well drained and moderately well drained soils on terraces and flood plains are well suited to most of the crops grown in the area. These include the Lynden, Kickerville, Laxton, and Tromp soils on glacial terraces and the Mt. Vernon and Puyallup soils on flood plains. Approximately 30,000 acres of the well drained soils is irrigated.

About 60 percent of the acreage used for crops and pasture in Whatcom County requires drainage of excess surface and subsurface water. Locating adequate outlets for drainage systems is difficult on the Bellingham and Labounty soils, which are in

depressions. These soils are used mainly for hay and late pasture unless they are drained. A combined surface and subsurface drainage system is used on poorly drained and very poorly drained soils to maximize the production of crops and forage. Drainage systems need to be maintained on Briscot, Oridia, Sumas, and Puget soils on flood plains and on Hale, Clipper, and Everson soils on glacial outwash terraces. The specific design of the drainage systems varies with the soil type and crop to be grown.

Most of the tillable soils in the survey area respond well to applications of fertilizer and lime. Most of the soils are medium acid or slightly acid and require lime to raise the pH value and increase the percent of base saturation. On all soils the amount of lime and fertilizer required should be based on a soil test, the needs of the crop, and the expected yield. Animal manure and sewage sludge can provide a significant portion of a crop's fertilizer needs. Application rates and timing vary with the type of soil, the needs of the crop, and the method of storage and distribution. The Soil Conservation Service can provide assistance in determining proper waste utilization on a specific soil and for a specific crop. The latest information and suggestions for growing crops can be obtained from the local office of the Cooperative Extension Service or the Soil Conservation Service.

### **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 6. 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 land capability classification of each map unit also is shown in the table.

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, animal 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.

Many of the soils in the survey area have adjacent layers with abrupt differences in texture and pore size. The pore size discontinuity influences the water-holding capacity of the soil. A soil underlain by sand, such as Lynden sandy loam, retains more water than a similar soil that has a uniform sandy loam profile. This increased water-holding capacity results from the inability of the sand to conduct water until the upper sandy loam layer has a sufficient water content to produce free water. The field capacity of the sandy loam will be about 10 percent higher than that derived from pressure membrane analysis.

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 6 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 (42). 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 criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include 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 are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

*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, 11e. The letter e shows that the main hazard is the 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, 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 acreage of soils in each capability class and subclass is shown in table 7. The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

## Woodland Management and Productivity

This section was prepared by Dennis J. Robinson, area forester, Soil Conservation Service; Sanderson Page, soil scientist, Soil Conservation Service; and Robert Freimark, forester, Washington State Department of Natural Resources.

Soils vary in their ability to produce and sustain woodland. The thickness of the soil, fertility, texture, and available water capacity, along with other factors, influence tree growth.

A majority of the soils in the survey area have the potential to produce wood crops. Most of the alluvial

soils have been converted from woodland to cropland used for the production of feed, forage, and truck crops. In their natural state, these soils supported coniferous and hardwood stands in varying degrees of mixture and density. Poorly drained and flood-influenced soils adjacent to bodies of water and major river and stream courses have the potential to support stands of red alder or black cottonwood interspersed with bigleaf maple and northwestern paper birch.

Elevation and aspect play a major role in determining the composition of species in a stand. In general, at elevations ranging from sea level to 3,000 feet above sea level, stands of Douglas fir and western hemlock are mixed to varying degrees. On south-facing slopes in the same elevation range, however, pure stands of Douglas fir occur (15). Western hemlock grows in pure stands at elevations of 1,600 to 2,000 feet and on north-facing slopes at lower elevations. At elevations above 3,000 feet, Pacific silver fir, western hemlock, mountain hemlock, and Alaska cedar are mixed to varying degrees. Pacific silver fir and some western hemlock also grow in narrow areas where cool air drains at elevations of 2,000 to 3,000 feet.

Red alder is the main deciduous tree in the survey area. Northwestern paper birch is a significant component of the hardwood stands. Red alder grows in pure stands and in mixed stands of deciduous and conifer species. It commonly invades clear-cut areas and becomes dominant unless intensive management practices are applied. A barren mineral soil, an adequate seed source, and an abundant supply of moisture are needed for the establishment of red alder (15).

In areas of soils that are influenced by serpentine, overstory vegetation is characterized by stunted, growth-inhibited stands of western hemlock, western redcedar, and Alaska cedar (20). Regeneration of harvested species is difficult on these soils. Planting stock should be obtained from suitable seed trees in the area.

Reforestation is the main concern affecting the production of timber on most of the soils in the survey area. Hand planting of adapted conifer seedlings is carried out in most areas. The presence of red alder and brush species is a significant deterrent to successful reforestation of conifers at elevations below 1,000 feet.

The main limitations affecting timber harvesting are the muddiness caused by seasonal wetness and the slope. A variety of equipment is used. Operating ground equipment on slopes that are steeper than 30 percent is considered hazardous. Cable systems that lift logs entirely off the ground are safer and less damaging to the soil. Using low-pressure ground equipment can

reduce the degree of soil compaction and displacement. In areas where the soils have a high content of phyllite, greater care is needed in the design and construction of roads and in the selection of harvesting equipment.

Many of the wood products produced in the survey area are transported to processing facilities outside of the area. Much of the wood for pulp is used locally at a large pulp and paper mill. Other processors in the area include a few shake and shingle mills, one plywood and veneer mill, four softwood lumber mills, and one outlet for posts, poles, and pilings. Red alder wood products are generally transported out of the survey area for processing.

A demand for urban and industrial development sites exists in the survey area. Total commercial woodland acreage may decline in the area as pressure to convert to other uses increases, but loss of productive acres may be partially offset by intensive management practices.

A statistical analysis was used in obtaining the woodland site data in this survey. Data from forest tree sites were taken by a forester. When a prospective tree stand on a particular map unit was identified by the forester, five site trees, generally the dominant trees on the site, were selected. Tree height, diameter at breast height, and breast-height age were determined. All ground vegetation also was identified and recorded on a data card (39).

On the basis of a 100-year site curve, the mean site index for the five trees was calculated by adjusting the breast-height age to total age for Douglas fir (28) and western hemlock (4). On the basis of a 50-year site curve, the mean site index was calculated directly from average breast-height age and total tree height for Douglas fir (22) and western hemlock (47). The site index for red alder was calculated in the same manner using average age at breast-height and total height (49). A statistical analysis of all site indices for each soil series or map unit was conducted. Standard deviation, standard error of the mean, and coefficient of variation were calculated (38).

All of the site data for a particular series was analyzed initially to obtain a coefficient of variation of less than 8 percent. If the 8 percent threshold was exceeded, then the site data applicable to each map unit within the series was analyzed in the same manner. If a 5 foot or more difference in site indices existed between map units, then those calculated site indices were used. If the difference was less than 5 feet and the coefficient of variation was less than 8 percent, the site indices were averaged for the series. For series without adequate site data, an estimated site index was established using data gathered for similar soils (45).

Soil surveys are becoming increasingly more

important to forest managers as they seek ways of increasing the productivity of their forested lands. Plants respond better to applications of fertilizers on some soils than on others. Some soils are more susceptible to landslides and erosion after road building and harvesting, and others require special effort to harvest and reforest.

Each description of the map units suitable for producing wood crops includes information about forest productivity, timber production, limitations affecting timber harvesting, and common forest understory plants. The methods and procedures used to develop the information for the map units are described in the *National Forestry Manual* (45) and the *Forest Land Grading Procedures Handbook* (39).

Table 8 summarizes forestry information given in the map unit descriptions and can serve as a quick reference for important forestry interpretations. Map unit symbols are listed, and the ordination (woodland suitability) symbol for each map unit in the table is given. All soils having the same ordination symbol require the same general kinds of forest management and have about the same potential productivity.

The *ordination symbol* is based on a uniform system that indicates the potential productivity of an individual soil and the principal hazards or limitations of that soil. The first element of the ordination symbol is a number that denotes the potential productivity in terms of cubic meters of wood per hectare per year for the indicator tree species. The potential productivity is based on the site index and the corresponding culmination of the mean annual increment. For example, the number 1 indicates a potential production of 1 cubic meter of wood per hectare (14.3 cubic feet per acre) per year and 10 indicates a potential production of 10 cubic meters of wood per hectare (143 cubic 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 stoniness or rockiness; *W*, excessive water, either seasonally or year round, in or on the soil; *T* toxic substances within the root zone; *D*, restricted rooting depth; *C*, clayey soils; *S*, sandy soils; *F*, fragmented or skeletal soils with coarse fragments that are more than 2 millimeters and less than 10 inches in size; and *R*, relief or slope. The letter *A* indicates no or only slight limitations affect use and management. If a soil has more than one limitation, the letter denoting the most limiting characteristic is used.

The number designation of the ordination symbol also represents the productivity class. Productivity class is calculated for other important common trees on the soil for which a site index has been provided. This

figure denotes potential productivity in terms of cubic meters of wood per hectare per year.

In table 8 the soils also are rated for a number of factors to be considered in management. Ratings of *slight*, *moderate*, and *severe* are used to indicate the degree of major soil limitations. For each moderate or severe rating, a sentence in the applicable map unit description explains the soil factor or factors that are the basis of that rating.

Ratings of *erosion hazard* indicate the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Ratings of the *equipment limitation* reflect the soil characteristics and conditions that restrict the use of equipment, either year round or seasonally. A rating of *slight* indicates that the use of equipment is not normally restricted to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation because of soil wetness, a fluctuating water table, or some other factor; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment. Slope and wetness are the main factors that cause equipment limitations. As slope gradient and length increase, using wheeled equipment becomes more difficult. On the steeper slopes, tracked equipment must be used. On the steepest slopes, even tracked equipment cannot be operated safely and more sophisticated systems must be used. Wetness, especially in combination with fine texture, can severely limit the use of equipment, making harvesting practical only during dry summer months.

Ratings of *seedling mortality* indicate the probability of the 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 naturally established seedlings that germinate during a period of insufficient soil moisture. A rating of *slight* indicates that no significant mortality is expected under usual conditions; *moderate* indicates that some mortality can be expected and that extra precautions are advisable; and *severe* indicates that mortality will be high and

extra precautions are essential for successful reforestation. Seedling mortality can be caused by wetness; by droughtiness in the surface layer, especially on south- or southwest-facing slopes; or by the position of the soil on a ridgetop. To offset these, larger than usual planting stock, special site preparation, a surface drainage system, or reinforcement planting may be needed.

Ratings of *windthrow hazard* are based on 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 normally are not blown down by the wind. Strong winds may break the trees but do not uproot them. A rating of *moderate* indicates that an occasional tree may be blown down during periods of excessive wetness and moderate or strong winds, and a rating of *severe* indicates that many trees are expected to be blown down during these periods. A restricted rooting depth caused by a high water table, underlying bedrock, and an impervious layer or poor anchoring of roots because of a loose surface layer and subsoil are responsible for windthrow. Moderate and severe ratings indicate the need for more care in thinning the edges of woodland stands, a plan calling for periodic removal of windthrow trees, and an adequate road and trail system to allow for this removal.

Ratings of *plant competition* indicate the likelihood of the invasion or growth of undesirable brushy plants when openings are made in the tree canopy. A rating of *slight* indicates that unwanted brushy plants are not likely to delay natural reforestation and that planted seedlings can survive and grow well 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. In many areas the key to predicting brush competition is the quantity and proximity of seed sources of undesirable plants or the quantity of unwanted bush rootstocks that will resprout after harvest activities. Moderate and severe ratings indicate the need for careful and thorough cleanup after harvest in preparation for reforestation and the possible need for mechanical or chemical treatment to retard the growth of brush and allow seedlings to become established.

The *potential productivity* of common trees on a soil is expressed as a *site index* and a *productivity class*. The site index is determined by measuring the height and age of selected trees within stands of a given species (4, 22, 28, 47, 49). It applies to fully stocked, even-aged, unmanaged stands. The greatest timber yields, usually expressed in board feet or cubic feet per

acre, can be expected from map units with the highest site index values. These values can be converted into estimated yields at various ages by carefully using appropriate yield publications (4, 9, 10, 28, 48, 49).

*Common trees* are listed in the same order as that of their general occurrence observed on the map unit. Generally, only one or two species will predominate.

*Trees to plant* are those that are planted for reforestation or that, under suitable conditions, are allowed to regenerate naturally. The species listed in table 8 are suited to the soils and can be used for commercial wood production. The desired product, the topographic position (such as a ridgetop), and personal preference are three of many factors that can influence the choice of suitable trees to use for reforestation.

## Windbreaks and Environmental Plantings

Dennis J. Robinson, area forester, Soil Conservation Service, helped to prepare this section.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Most of the lowland soils in the survey area were originally forested. A large portion of the native vegetation, however, has been cleared for farms and towns. In the north-central and northeast parts of the lowland area, between the towns of Everson and Sumas, windbreaks protect farm buildings and houses from northeast winds. Weather systems moving southwest from the Fraser River Valley of Canada bring snow and cold, desiccating winds to the area. As a result, windbreaks are needed for protection. Windbreaks and environmental plantings can be established. Measures that maintain them are needed. Plantings can include a single species or a variety of species.

The most effective arrangement of windbreak plantings consists of dense, low-growing shrubs in the windward rows, taller deciduous trees or shrubs in the center row or rows, and evergreen trees or shrubs on the leeward side (44). Such an arrangement makes the windbreak more effective in winter. If only one or two rows are planted, species that provide maximum protection should be selected. For example, if protection of a large area is needed, tall trees should be planted, or if control of ground winds is needed, dense shrubs or evergreens are most effective. Generally, wind movement on the leeward side of the planting is effectively reduced to a distance equal to 10 to 20 times the height of the windbreak.

Plants suitable for windbreaks and environmental

plantings in the survey area have not been tested. Many windbreaks that are installed consist primarily of adapted native species of deciduous trees and shrubs and coniferous trees. Lombardy poplar is the most suitable deciduous tree. Douglas fir, Rocky Mountain juniper, western redcedar, ponderosa pine, and grand fir are the most commonly used evergreen species. Native and adapted shrub species, such as willows and common lilac, are suitable for use in the low-growing shrub row in the windbreak plantings. Generally, adequate moisture for growth is provided by normal precipitation. Irrigation may be necessary, however, on the drier sites in late August and September.

The spacing between rows and between the trees and shrubs in the rows is important. Deciduous trees should be spaced at least 12 feet apart in the row, shrubs should be 3 or 4 feet apart, and evergreen trees should be at least 6 feet apart. The rows of trees should be 12 to 18 feet apart. The size of the cultivating equipment is a consideration in row-to-row spacing.

Other aspects of layout are equally important. Farmstead windbreaks should be at least 100 feet from the buildings so that air can move on hot days. Rounded corners are easier to cultivate than square ones. Areas to be planted should be free of vegetation before the trees or shrubs are planted.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a local nursery.

## Recreation

Whatcom County has many areas of scenic, recreational, geologic, and historic interest. These areas are used for camping, hiking, hunting, fishing, sightseeing, mountain climbing, bicycling, picnicking, and boating. Public areas available for recreation within the survey area include eight county parks, three state parks, a state game range, and several fish hatcheries.

Important marine features include Lummi and Eliza Islands, Point Francis, Bellingham Bay, numerous beaches, and scenic Chuckanut Drive, which follows the water's edge south of Bellingham. The western boundary of Mount Baker National Forest is the eastern boundary of the survey area. Lake Whatcom, Lake Samish, the Nooksack River, and the Strait of Georgia

are prime fishing areas. Mount Baker and Twin Sisters Mountain, immediately east of the survey area, are important recreational areas.

The soils of the survey area are rated in table 9 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 sewer lines. 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 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

*Camp areas* require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

*Picnic areas* are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

*Playgrounds* require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

*Paths and trails* for hiking 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

The survey area contains a wide variety of habitat types ranging from salt water to alpine mountain peaks, which support a variety of wildlife. Approximately three-fourths of the survey area on the western slope of the Cascade Range is covered by coniferous forests. Numerous rocky peaks, which are above 8,000 feet, provide a home for species characteristic of these alpine environments. These species include pika, white-tailed ptarmigan, and mountain goat.

The western one-fourth of the survey area consists of lowlands and relatively flat terrain, which is used mainly for agriculture. Agricultural land is interspersed with numerous remnant patches of coniferous forest and riparian woodland. These small wooded areas support woodland wildlife and provide cover for openland wildlife. The lowlands contain numerous wetlands, sloughs, and creeks, which provide important habitat for fish, waterfowl, and other aquatic and wetland wildlife.

Much of the survey area is drained by the Nooksack River, which flows into Bellingham Bay. About 650 rivers and streams are in the Nooksack drainage system, which includes about 1,300 miles of streams and tributaries. Bald eagles concentrate along the river in winter to feed on the salmon, steelhead, and cutthroat trout that migrate upstream each year. In an average year, about 55,000 adult salmon return to spawn in the Nooksack drainage system.

Bellingham, Lummi, Chuckanut, and Birch Bays provide habitat for saltwater fish and shellfish. An

abundance of marine invertebrates and aquatic vegetation attract large resident and wintering populations of loons, grebes, cormorants, herons, ducks, shorebirds, gulls, ferns, and black brants.

Soils and climate 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 10, 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, brome grass, 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, 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, available water capacity, and wetness. Examples of these plants are red alder, bigleaf maple, Pacific dogwood, cottonwood, vine maple, and willow. Examples of fruit-producing trees and shrubs that are suitable for planting on soils rated *good* are blackberry, apple, cherry, crabapple, and mountain ash.

*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, Oregon grape, and salmonberry.

*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. Wildlife attracted to these areas include California quail, pheasant, mourning dove, meadowlark, chipping sparrow, and brush rabbit.

*Habitat for woodland wildlife* consists of areas of deciduous and coniferous plants and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include blue and ruffed grouse, thrushes, woodpeckers, squirrels, Cascade red fox, mountain goat, ptarmigan, 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 or 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 evaluate the potential of areas for residential, commercial, industrial, and recreation uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

## Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

*Shallow excavations* are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging,

filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and 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, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

*Local roads and streets* have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

*Lawns and landscaping* require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

### **Sanitary Facilities**

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations

are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 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 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

*Sanitary landfills* are areas where solid waste is disposed of by burying it in soil. There are two types of landfill-trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 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 13 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 to 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, a 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 a 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 depth to the water table is less than 1 foot. These soils 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 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

*Topsoil* is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils

are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

## Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

*Pond reservoir areas* hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

*Embankments, dikes, and levees* are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable

compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

*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 control 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

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Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, 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 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

*Depth* to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

*Texture* is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52

percent sand. If 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 Unified soil classification system (2) and the system adopted by the American Association of State Highway and Transportation Officials (1). Both systems are described in the *PCA Soil Primer* (33).

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, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

*Rock fragments* larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

*Percentage (of soil particles) passing designated sieves* is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and

in nearby areas and on estimates made in the field.

*Liquid limit* and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally 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 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

*Clay* as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

*Moist bulk density* is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

*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.

*Salinity* is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

*Shrink-swell potential* is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the

change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

*Erosion factor K* indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

*Erosion factor T* is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

*Wind erodibility groups* are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

- 4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay

loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

*Organic matter* is the plant and animal residue in the soil at various stages of decomposition. In table 16, 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 in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

## Soil and Water Features

Tables 17 and 18 give estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

*Hydrologic soil groups* are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the

surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

*Flooding*, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *brief* if less than 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

*High water table* (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 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 commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

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 one by a dry zone.

Only saturated zones within a depth of about 6 feet

are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

*Depth to bedrock* is given in table 18 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 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.

*Cemented pans* are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

*Subsidence* is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 18 shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

*Potential frost action* is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the 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.

Soils in Whatcom County that are below an elevation of approximately 800 feet are not usually subject to potential frost action.

*Risk of corrosion* pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe

corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate, or high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate, or high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

# Classification of the Soils

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The system of soil classification used by the National Cooperative Soil Survey has six categories (43). 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 19 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

**ORDER.** Eleven 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 Spodosol.

**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 Orthod (*Orth*, meaning true, plus *od*, from Spodosol).

**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 Haplorthods (*Hapl*, meaning minimal horizonation, plus *orthod*, a suborder of Spodosols).

**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 *Aqualfic* identifies the subgroup that is saturated with water at some time of the year and has an argillic horizon. An example is Aqualfic Haplorthods.

**FAMILY.** Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Aqualfic Haplorthods.

**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* (41). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (43). 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 formed in a mixture of volcanic ash and loess, over, glacial outwash. These

soils are on outwash terraces and terrace escarpments. Slopes are 0 to 60 percent. The average annual precipitation is 60 to 75 inches, and the mean annual air temperature is about 47 degrees F.

These soils are sandy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Barneston gravelly loam, 0 to 8 percent slopes, 1 mile southeast of Kendall, 2,000 feet north and 1,250 feet west of the southeast corner of sec. 35, T. 40 N., R. 5 E.

Oi-2.5 to 2 inches; undecomposed needles, leaves, and twigs.

Oa-2 inches to 0; decomposed organic mat; many fine and medium roots.

E-0 to 1.5 inches; brown (7.5YR 5/2) gravelly loam, pinkish gray (7.5YR 6/2) dry; weak fine and medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, and medium roots; many fine irregular pores; about 20 percent pebbles; NaF pH 9.4; strongly acid; clear smooth boundary.

Bs1-1.5 to 8 inches; dark brown (7.5YR 3/4) gravelly loam, brown (7.5YR 5/4) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, and medium roots; many fine irregular pores; about 30 percent pebbles; NaF pH 11.0; strongly acid; clear wavy boundary.

Bs2-8 to 14 inches; dark brown (7.5YR 3/4) very gravelly loam, light brown (7.5YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and many fine roots; many fine irregular pores; about 45 percent pebbles; NaF pH 11.5; strongly acid; clear wavy boundary.

2C1-14 to 28 inches; dark yellowish brown (10YR 4/4) extremely gravelly sand, light yellowish brown (10YR 6/4) dry; single grain; loose; many fine and few medium roots; many medium and coarse irregular pores; about 70 percent pebbles and 5 percent cobbles; NaF pH 11.5; strongly acid; clear smooth boundary.

2C2-28 to 40 inches; olive brown (2.5Y 4/4) extremely gravelly sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose; common fine and few medium roots; many medium and coarse subangular pores; about 75 percent pebbles and 5 percent cobbles; moderately acid; clear smooth boundary.

2C3-40 to 60 inches; dark grayish brown (2.5Y 4/2) extremely gravelly sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; few medium roots; many medium and coarse irregular pores; about 70

percent pebbles and 5 percent cobbles; moderately acid.

The thickness of the solum and of the part of the profile influenced by volcanic ash is 13 to 24 inches. The content of clay in the lower part of the particle-size control section is 0 to 3 percent. By weighted average, the upper part of the control section has 35 to 60 percent pebbles and 0 to 10 percent cobbles and the lower part has 45 to 70 percent pebbles, 5 to 15 percent cobbles, and 0 to 15 percent stones.

The E horizon has hue of 7.5YR or 10YR, value of 2 to 5 when moist and 4 to 7 when dry, and chroma of 2 to 4 when moist and dry. Some pedons have an A horizon.

The Bs horizon has hue of 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 dry. It is gravelly loam, gravelly sandy loam, very gravelly loam, or very gravelly sandy loam.

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 2 to 6 when moist and dry. It is very gravelly loamy sand, very gravelly sand, extremely gravelly loamy sand, or extremely gravelly sand.

### **Barnhardt Series**

The Barnhardt series consists of very deep, well drained soils formed in a mixture of volcanic ash, loess, and glacial outwash. These soils are on terraces. Slopes are 0 to 5 percent. The average annual precipitation is about 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

These soils are loamy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Barnhardt gravelly loam, 0 to 5 percent slopes, about 2 miles southwest of Everson, 250 feet south and 1,900 feet west of the northeast corner of sec. 11, T. 39 N., R. 3 E.

Oi-1 inch to 0; undecomposed needles, leaves, and twigs.

A-0 to 3 inches; dark brown (7.5YR 3/2) gravelly loam, brown (10YR 5/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and common fine roots; many very fine irregular pores; about 20 percent pebbles; NaF pH 10.0; slightly acid; clear wavy boundary.

Bs1-3 to 9 inches; dark brown (7.5YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many

very fine and common fine roots; many very fine irregular pores; about 25 percent pebbles; NaF pH 10.5; moderately acid; clear wavy boundary.

Bs2-9 to 21 inches; yellowish brown (10YR 5/4) extremely gravelly loam, very pale brown (10YR 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine, common fine, and few medium roots; many very fine irregular pores; about 60 percent pebbles; NaF pH 10.5; moderately acid; gradual wavy boundary.

BC-21 to 42 inches; yellowish brown (10YR 5/4) extremely gravelly sandy loam, pale yellow (2.5Y 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, medium, and coarse roots; many very fine irregular pores; about 75 percent pebbles; NaF pH 10.5; moderately acid; gradual wavy boundary.

C-42 to 60 inches; yellowish brown (10YR 5/4) extremely gravelly loam, very pale brown (10YR 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few very fine roots; many very fine irregular pores; about 70 percent pebbles; NaF pH 9.6; moderately acid.

The part of the profile influenced by volcanic ash is 60 or more inches thick. The thickness of the solum is 8 to 30 inches. The particle-size control section has 50 to 75 percent pebbles and 0 to 5 percent cobbles by weighted average.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist, and chroma of 2 to 4 when moist and dry.

The Bs horizon has hue of 7.5YR or 10YR and value of 4 or 5 when moist and 6 or 7 when dry. It is gravelly loam, very gravelly loam, very gravelly silt loam, or extremely gravelly loam.

The BC and C horizons have 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 and dry. Within the particle-size control section, they are very gravelly loam, extremely gravelly sandy loam, or very gravelly silt loam. Below the control section, they are extremely gravelly loam, extremely gravelly sandy loam, or extremely gravelly loamy sand.

### **Bellingham Series**

The Bellingham series consists of very deep, poorly drained soils formed in an admixture of loess, alluvium, and lacustrine deposits. These soils are in depressions on terraces. Slopes are 0 to 2 percent. The average

annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

These soils are fine, mixed, nonacid, mesic Mollic Haplaquepts.

Typical pedon of Bellingham silty clay loam, 0 to 2 percent slopes, 1.5 miles north of Everson, 2,200 feet south and 100 feet east of the northwest corner of sec. 19, T. 40 N., R. 4 E.

Ap-0 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; many very fine and fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

Bg1-10 to 18 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 4/3) silty clay loam, grayish brown (10YR 5/2) and pale brown (10YR 6/3) dry; common fine prominent mottles, yellowish brown (10YR 5/6) moist and dry; moderate fine subangular blocky structure; slightly hard, firm, slightly sticky and plastic; common very fine and few fine roots; many very fine irregular pores; few patchy clay films on faces of peds; slightly acid; abrupt smooth boundary.

Bg2-18 to 24 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) silty clay loam, light gray (2.5Y 7/2) and pale yellow (2.5Y 7/4) dry; common medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; weak coarse prismatic structure parting to medium fine subangular blocky; very hard, firm, slightly sticky and plastic; common very fine roots; many very fine irregular pores; neutral; clear smooth boundary.

CB-24 to 30 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; many medium distinct light olive brown (2.5Y 5/4) mottles, light yellowish brown (2.5Y 6/4) dry; moderate medium subangular blocky structure; very hard, firm, slightly sticky and plastic; few very fine roots; common very fine irregular pores; few patchy clay films on faces of peds; neutral; clear smooth boundary.

C1-30 to 38 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (5Y 7/1) dry; common fine prominent light olive brown (2.5Y 5/4) mottles, light yellowish brown (2.5Y 6/4) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, slightly sticky and plastic; few very fine roots; neutral; clear smooth boundary.

C2-38 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, white (2.5Y 8/2) dry; common fine prominent light olive brown (2.5Y 5/4) mottles, light yellowish brown (2.5Y 6/4) dry; moderate coarse prismatic

structure parting to moderate medium subangular blocky; very hard, firm, slightly sticky and plastic; few very fine roots; neutral.

The particle-size control section has 35 to 60 percent clay by weighted average. The thickness of the solum is 10 to 30 inches.

The Ap horizon has value of 2 or 3 when moist and 4 or 5 when dry and chroma of 1 to 3 when moist and dry.

The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6 when moist and 5 to 8 when dry, and chroma of 1 to 3 when moist and dry. It is silty clay loam or silty clay.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 when moist and 7 or 8 when dry, and chroma of 1 or 2 when moist and dry. It is dominantly silty clay loam, silty clay, or clay. In some pedons, however, it has thin strata of silt loam or sandy loam.

The Bellingham soils in this survey area are taxadjuncts to the series because they have a mollic epipedon. This difference, however, does not significantly affect the use and management of the soils.

### **Birchbay Series**

The Birchbay series consists of very deep, moderately well drained soils formed in an admixture of loess and volcanic ash over glaciofluvial deposits and glaciomarine drift. These soils are on wave-reworked glaciomarine drift plains. Slopes are 0 to 15 percent. The average annual precipitation is 30 to 40 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Birchbay silt loam, 0 to 3 percent slopes, 5 miles west of Ferndale, 2,400 feet south and 1,600 feet east of the northwest corner of sec. 16, T. 39 N., R. 1 E.

Ap-0 to 8 inches; dark brown (10YR 3/3) silt loam, dark yellowish brown (10YR 4/4) dry; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine roots; many very fine irregular pores; about 2 percent pebbles; NaF pH 9.8; slightly acid; abrupt smooth boundary.

Bs1-8 to 12 inches; dark brown (7.5YR 4/4) silt loam, strong brown (7.5YR 5/6) 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; about 10

percent pebbles; NaF pH 10.5; moderately acid; clear smooth boundary.

Bs2-12 to 24 inches; dark yellowish brown (10YR 4/4) 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 fine roots; many very fine irregular pores; about 20 percent pebbles; NaF pH 11.0; moderately acid; clear smooth boundary.

2C1-24 to 42 inches; dark yellowish brown (10YR 4/4) very gravelly sand, brownish yellow (10YR 6/6) dry; massive; slightly hard, very friable, nonsticky and nonplastic; very few fine roots; many fine irregular pores; about 35 percent pebbles and 5 percent cobbles; NaF pH 11.0; moderately acid; clear wavy boundary.

3C2-42 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; many large prominent strong brown (7.5YR 5/6) mottles, reddish yellow (7.5YR 6/6) dry; massive; very hard, firm, slightly sticky and slightly plastic; few fine irregular pores; about 10 percent pebbles; moderately acid.

The thickness of the part of the profile influenced by volcanic ash and the depth to the 2C horizon are 14 to 32 inches. Depth to the 3C horizon is 40 to 60 inches.

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 2 to 4 when moist and 3 or 4 when dry.

The Bs 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 and dry. It is silt loam, loam, gravelly silt loam, or gravelly loam.

The 2C horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist and 2 to 6 when dry. It is very gravelly loamy sand or very gravelly sand.

The 3C horizon has hue of 10YR to 5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist and dry. It is dominantly loam, gravelly loam, clay loam, gravelly clay loam, or silty clay loam. In some pedons, however, it has thin strata of sandy loam.

### **Blainegate Series**

The Blainegate series consists of very deep, poorly drained soils formed in marine deposits. These soils are on marine terraces. Slopes are 0 to 1 percent. The average annual precipitation is 30 to 40 inches, and the mean annual air temperature is about 50 degrees F.

These soils are very fine, mixed, mesic Typic Argiaquolls.

Typical pedon of Blainegate silty clay, 0 to 1 percent slopes, 1 mile east of Blaine, 2,600 feet south and 1,800 feet east of the northwest corner of sec. 5, T. 40 N., R. 1 E.

- Ap-0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; few fine prominent yellowish brown (10YR 5/8) mottles, brownish yellow (10YR 6/8) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and plastic; many very fine and common fine roots; many very fine irregular pores; moderately acid; abrupt smooth boundary.
- Btg-9 to 27 inches; dark gray (5Y 4/1) clay, light gray (5Y 7/1) dry; many fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, sticky and plastic; many very fine and common fine roots; many very fine irregular and common very fine tubular pores; few patchy clay films on faces of peds; slightly acid; clear smooth boundary.
- C1-27 to 45 inches; gray (5Y 6/1) clay, white (5Y 8/1) dry; many fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; hard, firm, sticky and plastic; common very fine roots; few very fine irregular and common very fine tubular pores; neutral; clear smooth boundary.
- C2-45 to 60 inches; light brownish gray (2.5Y 6/2) clay, white (2.5Y 8/2) dry; many coarse prominent light olive brown (2.5Y 5/6) mottles, olive yellow (2.5Y 6/6) dry; massive; hard, firm, sticky and plastic; common very fine roots; few very fine irregular and common very fine tubular pores; neutral.

The particle-size control section has 60 to 75 percent clay by weighted average. The thickness of the solum is 10 to 30 inches.

The Ap horizon has value of 2 or 3 when moist and 4 or 5 when dry and chroma of 1 to 3 when moist and dry. The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6 when moist and 5 to 8 when dry, and chroma of 1 or 2 when moist and dry. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 when moist and 7 or 8 when dry, and chroma of 1 or 2 when moist and dry. In some pedons it has thin strata of silt loam, silty clay loam, or sandy loam.

### **Blethen Series**

The Blethen series consists of very deep, well drained soils formed in glacial till, colluvium, and slope alluvium with an admixture of volcanic ash and loess. These soils are on side slopes and toe slopes of

foothills and landslides. Slopes are 5 to 60 percent. The average annual precipitation is 50 to 70 inches, and the mean annual air temperature is about 47 degrees F.

These soils are loamy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Blethen gravelly loam, 15 to 30 percent slopes, 10 miles east of Lynden, 1,300 feet north and 500 feet east of the southwest corner of sec. 13, T. 40 N., R. 4 E.

- Oi-0.75 to 0.25 inch; leaves, needles, twigs, and cones.
- Oa-0.25 inch to 0; decomposed needles, leaves, and twigs; common very fine and fine roots.
- A1-0 to 2 inches; dark brown (7.5YR 3/3) gravelly loam, brown (7.5YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; many very fine and fine and common medium roots; many very fine irregular pores; about 15 percent pebbles and 5 percent cobbles; NaF pH 9.8; slightly acid; clear smooth boundary.
- A2-2 to 6 inches; dark brown (7.5YR 3/3) gravelly loam, strong brown (7.5YR 4/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common very fine, fine, and medium and few coarse roots; common very fine irregular pores; about 15 percent pebbles and 5 percent cobbles; NaF pH 10.1; moderately acid; clear smooth boundary.
- Bs1-6 to 18 inches; dark brown (7.5YR 4/4) very cobbly loam, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common very fine, fine, medium, and coarse roots; common very fine irregular pores; about 25 percent pebbles and 15 percent cobbles; NaF pH 10.1; moderately acid; clear wavy boundary.
- Bs2-18 to 28 inches; dark yellowish brown (10YR 4/4) very cobbly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine and medium and few coarse roots; common very fine irregular pores; about 25 percent pebbles and 15 percent cobbles; NaF pH 10.5; moderately acid; gradual smooth boundary.
- Bs3-28 to 41 inches; dark yellowish brown (10YR 4/4) very cobbly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; weakly smeary; few fine and medium roots; many very fine irregular pores; about 30 percent pebbles and 20 percent cobbles; NaF pH 10.1; moderately acid;

gradual smooth boundary.

C-41 to 60 inches; olive brown (2.5Y 4/4) very cobbly loam, light yellowish brown (10YR 6/4) dry; massive; hard, friable, nonsticky and nonplastic; weakly smeary; few fine roots; few very fine irregular pores; about 40 percent pebbles and 20 percent cobbles; NaF pH 10.6; slightly acid.

The thickness of the solum and of the part of the profile influenced by volcanic ash is 26 to 50 inches. The content of rock fragments in the control section ranges from 35 to 60 percent. It includes 30 to 50 percent pebbles and 5 to 20 percent cobbles.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry.

The Bs 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 and dry. It is very gravelly loam, very gravelly silt loam, very cobbly loam, or very cobbly silt loam.

The C horizon has hue of 10YR or 2.5YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 3 or 4 when moist and dry. It is very gravelly loam, very gravelly sandy loam, very cobbly loam, or very cobbly sandy loam.

### **Briscot Series**

The Briscot series consists of very deep, poorly drained soils that have been artificially drained. They formed in alluvium on flood plains. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy, mixed, nonacid, mesic Aeric Fluvaquents.

Typical pedon of Briscot silt loam, drained, 0 to 2 percent slopes, 3 miles south of Sumas, 400 feet south and 2,400 feet east of the northwest corner of sec. 15, T. 40 N., R. 4 E.

Ap-0 to 9 inches; dark grayish brown (2.5Y 4/2) silt loam, light gray (2.5Y 5/2) dry; moderate medium subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium roots; many very fine irregular and many very fine tubular pores; few fine pebbles; moderately acid; abrupt smooth boundary.

C1-9 to 14 inches; dark grayish brown (2.5Y 4/2) silt loam, light gray (2.5Y 7/2) dry; common fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; moderate coarse

subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium roots; many very fine irregular and many very fine tubular pores; moderately acid; abrupt wavy boundary.

C2-14 to 22 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam, light gray (2.5Y 7/2) dry; many large prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine and common fine roots; many very fine irregular and many very fine tubular pores; moderately acid; abrupt smooth boundary.

C3-22 to 34 inches; gray (5Y 6/1) fine sand, light gray (5Y 7/1) dry; many large prominent olive brown (2.5Y 4/4) mottles, light yellowish brown (2.5Y 6/4) dry; massive; soft, friable, nonsticky and nonplastic; common very fine and few medium roots; many very fine irregular pores; slightly acid; abrupt smooth boundary.

C4-34 to 41 inches; gray (5Y 5/1) fine sandy loam, light gray (5Y 7/1) dry; many large prominent olive brown (2.5Y 4/4) mottles, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; slightly acid; abrupt smooth boundary.

C5-41 to 60 inches; gray (5Y 5/1) and light brownish gray (2.5Y 6/2) silt loam, light gray (5Y 7/1 and 2.5Y 7/2) dry; many medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine irregular and common very fine tubular pores; slightly acid.

The control section is, by weighted average, 5 to 12 percent clay and 15 to 60 percent sand coarser than very fine sand. These soils have an irregular distribution of organic matter with increasing depth.

The A horizon has hue of 10YR or 2.5Y and value of 3 or 4 when moist and 6 or 7 when dry. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 7 when dry, and chroma of 1 or 2 when moist and dry. It has mottles with hue of 10YR or 2.5Y, value of 4 or 5 when moist, and chroma of 4 to 6 when moist and dry. It is stratified silt loam, very fine sandy loam, fine sandy loam, fine sand, or sand.

### **Chuckanut Series**

The Chuckanut series consists of deep and very deep, well drained soils formed in a mixture of volcanic ash and colluvium derived from glacial drift and

sandstone. These soils are on foothill side slopes, back slopes, toe slopes, and landslides. Slopes are 3 to 60 percent. The average annual precipitation is 35 to 60 inches, and the mean annual air temperature is about 49 degrees F.

These soils are coarse-loamy, mixed, mesic Typic Haplothods.

Typical pedon of Chuckanut loam, 3 to 8 percent slopes, 3 miles southwest of Van Zandt, 1,000 feet south and 900 feet east of the northwest corner of sec. 19, T. 38 N., R. 4 E.

Ap-0 to 10 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots; many very fine irregular pores; few soft pebbles; NaF pH 11.0; moderately acid; clear smooth boundary.

Bw1-10 to 12 inches; olive brown (2.5Y 4/4) sandy loam, pale yellow (2.5Y 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine roots; few soft pebbles; NaF pH 11.0; moderately acid; clear smooth boundary.

Bw2-12 to 24 inches; dark brown (10YR 3/3) gravelly loam, pale brown (10YR 6/3) dry; weak fine subangular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine roots; many very fine irregular pores; about 15 percent hard pebbles and 5 percent soft pebbles; NaF pH 10.2; moderately acid; clear smooth boundary.

C-24 to 60 inches; olive brown (2.5Y 4/4) gravelly sandy loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine roots; many very fine irregular pores; about 20 percent hard pebbles and 60 percent soft pebbles; NaF pH 10.2; slightly acid.

The depth to sandstone is 40 to more than 60 inches. By weighted average, the content of rock fragments in the control section is 0 to 15 percent hard pebbles, 35 to 60 percent soft pebbles, and 0 to 5 percent hard cobbles.

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 2 or 3 when moist and 2 to 4 when dry.

The Bw horizon has hue of 7.5YR to 2.5Y, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist and dry. It is gravelly loam, gravelly sandy loam, or gravelly fine sandy loam.

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 and dry. It is gravelly loam or gravelly sandy loam.

### Clendenen Series

The Clendenen series consists of shallow, moderately well drained soils formed in a mixture of volcanic ash, loess, and colluvium over glacial till. These soils are on mountain back slopes and shoulder slopes. Slopes are 5 to 30 percent. The average annual precipitation is 80 to 100 inches, and the mean annual air temperature is about 41 degrees F.

These soils are loamy-skeletal, mixed, shallow Humic Cryorthods.

Typical pedon of Clendenen gravelly silt loam, 5 to 30 percent slopes, 800 feet north and 800 feet west of the southeast corner of sec. 33, T. 38 N., R. 6 E.

Oi-7 to 3 inches; undecomposed needles, leaves, and twigs.

Oa-3 inches to 0; decomposed forest litter; many fine, medium, and coarse roots.

E-0 to 2 inches; reddish gray (5YR 5/2) gravelly silt loam, pinkish gray (5YR 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; about 20 percent pebbles; many very fine roots; common fine irregular pores; very strongly acid; abrupt smooth boundary.

Bhs-2 to 5 inches; strong brown (7.5YR 4/6) gravelly silt loam, strong brown (7.5YR 5/6) dry; dark brown (7.5YR 3/2) organic stains, dark brown (7.5YR 4/4) dry; moderate medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; weakly smeary; common fine and medium roots; common very fine irregular pores; about 15 percent pebbles; strongly acid; clear smooth boundary.

Bs-5 to 16 inches; strong brown (7.5YR 5/6) very gravelly silt loam, reddish yellow (7.5YR 6/6) dry; moderate fine and medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; weakly smeary; about 40 percent pebbles; few fine roots; many very fine irregular pores; moderately acid; abrupt smooth boundary.

2Cd-16 to 60 inches; pale brown (10YR 6/3), dense glacial till that breaks to very gravelly loam, very pale brown (10YR 7/3) dry; yellowish red (5YR 4/6) organic stains, yellowish red (5YR 5/6) dry; massive; hard, firm, slightly sticky and slightly plastic; about 50 percent pebbles; moderately acid.

The depth to dense, compact glacial till is 14 to 20 inches. The content of rock fragments in the control section ranges from 40 to 65 percent.

The E horizon has hue of 5YR or 7.5YR and value of

4 or 5 when moist and 6 or 7 when dry.

The Bh<sub>s</sub> and Bs horizons have hue of 5YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist and dry. The fine-earth fraction is loam or silt loam.

The 2Cd horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist and dry. It is dense glacial till that breaks to very gravelly loam or very gravelly sandy loam.

### Clipper Series

The Clipper series consists of very deep, somewhat poorly drained soils formed in an admixture of loess and volcanic ash over glacial outwash. These soils are in depressions on outwash terraces and outwash plains. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy, mixed, mesic Aquic Haplothods.

Typical pedon of Clipper silt loam, drained, 0 to 2 percent slopes, 4 miles northeast of Lynden, 500 feet north and 2,400 feet east of the southwest corner of sec. 34, T. 41 N., R. 3 E.

Ap-0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many very fine roots; many very fine irregular and few fine tubular pores; about 5 percent pebbles; NaF pH 9.4; slightly acid; abrupt smooth boundary.

E1-9 to 18 inches; grayish brown (2.5Y 5/2) and gray (10YR 6/1) silt loam, light gray (2.5Y 7/2) and white (10YR 8/1) dry; many medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular and few very fine tubular pores; few pebbles; strongly acid; abrupt smooth boundary.

2E2-18 to 22 inches; grayish brown (2.5Y 5/2) and gray (10YR 5/1) gravelly sandy loam, light gray (2.5Y 7/2 and 10YR 7/1) dry; many medium prominent strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine irregular pores; about 30 percent pebbles; moderately acid; clear smooth boundary.

2Bs-22 to 30 inches; yellowish brown (10YR 5/8) very gravelly sandy loam, brownish yellow (10YR 6/8)

dry; many medium prominent grayish brown (2.5Y 5/2) mottles, light gray (2.5Y 7/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; very few very fine roots; many very fine irregular pores; about 30 percent pebbles; moderately acid; clear smooth boundary.

3C1-30 to 37 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) very gravelly loamy sand, light gray (2.5Y 7/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine irregular pores; about 50 percent pebbles and 5 percent cobbles; moderately acid; clear smooth boundary.

3C2-37 to 60 inches; dark grayish brown (2.5Y 4/2) very gravelly loamy sand, light brownish gray (2.5Y 6/2) dry; many fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; soft, friable, nonsticky and nonplastic; many very fine irregular pores; about 50 percent pebbles and 5 percent cobbles; moderately acid.

The thickness of the solum is 14 to 30 inches. By weighted average, the solum has 10 to 18 percent clay and the particle-size control section ranges from 15 to 35 percent rock fragments. The content of rock fragments increases with increasing depth. It ranges from 10 to 25 percent in the solum and from 25 to 60 percent in the substratum.

The A horizon has chroma of 2 or 3 when moist and dry. The E horizon has hue of 10YR to 5Y, value of 5 or 6 when moist and 7 or 8 when dry, and chroma of 1 or 2 when moist and dry. It is silt loam, loam, gravelly loam, or gravelly silt loam. The 2E horizon has hue of 10YR to 5Y, value of 5 or 6 when moist and 7 or 8 when dry, and chroma of 1 or 2 when moist and dry. It is mottled. It is gravelly sandy loam or gravelly loam.

The 2Bs 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 to 8 when moist and dry. It is gravelly loam, gravelly sandy loam, very gravelly loam, or very gravelly sandy loam.

The 3C 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 dry. It is massive or single grain and is loose, soft, or slightly hard. It is very gravelly loamy sand or very gravelly sand.

### Comar Series

The Comar series consists of deep, moderately well drained soils formed in a mixture of volcanic ash,

colluvium, and slope alluvium derived from siltstone and glacial till. These soils are on foothill back slopes and toe slopes. Slopes are 5 to 60 percent. The average annual precipitation is 50 to 65 inches, and the mean annual temperature is about 47 degrees F.

These soils are fine-loamy, mixed, mesic Typic Haplothods.

Typical pedon of Comar silt loam, 30 to 60 percent slopes, 1.5 miles northeast of Deming, 2,200 feet due south of the northwest corner of sec. 29, T. 39 N., R. 5 E.

Oi-5 to 4 inches; undecomposed needles, leaves, and twigs.

Oa-4 inches to 0; decomposed forest litter; many very fine, fine, medium, and coarse roots.

A-0 to 5 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many very fine, fine, medium, and coarse roots; many fine irregular pores; about 30 percent weathered pebbles and 10 percent unweathered pebbles; NaF pH 10.0; moderately acid; clear smooth boundary.

Bs-5 to 16 inches; brown (10YR 4/3) silt loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine and common medium and coarse roots; many fine irregular pores; about 20 percent weathered pebbles and 5 percent unweathered pebbles; NaF pH 10.5; moderately acid; clear smooth boundary.

2C1-16 to 39 inches; light olive brown (2.5Y 5/4) silt loam, very pale brown (10YR 7/3) dry; massive; very hard, firm, sticky and plastic; many very fine and fine and few medium roots; many fine and medium irregular pores; about 75 percent weathered pebbles; NaF pH 9.4; strongly acid; clear smooth boundary.

2C2-39 to 44 inches; light olive brown (2.5Y 5/4) silt loam; pale yellow (2.5YR 7/4) dry; massive; very hard, firm, sticky and plastic; common very fine and fine and few medium roots; many fine and medium irregular pores; about 60 percent weathered pebbles; strongly acid; abrupt wavy boundary.

2Cr-44 inches; siltstone.

The depth to siltstone is more than 40 inches. The lower part of the control section has 20 to 30 percent clay. The thickness of the part of the profile influenced by volcanic ash is 14 to 24 inches. The content of rock fragments in the particle-size control section ranges

from 0 to 25 percent unweathered pebbles and 15 to 80 percent weathered pebbles.

The A horizon has chroma of 3 or 4 when moist and dry. The Bs horizon has value of 5 or 6 when dry and chroma of 3 or 4 when moist and dry. It is loam or silt loam. The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 to 8 when dry, and chroma of 3 or 4 when moist and dry. It is silt loam, silty clay loam, or gravelly silt loam.

### **Crinker Series**

The Crinker series consists of moderately deep, well drained soils formed in an admixture of volcanic ash, colluvium, slope alluvium, and glacial till derived dominantly from phyllite. These soils are on high mountain back slopes and shoulder slopes. Slopes are 30 to 60 percent. The average annual precipitation is 80 to 95 inches, and the mean annual air temperature is about 42 degrees F.

These soils are loamy-skeletal, mixed Typic Cryorthods.

Typical pedon of Crinker very channery silt loam, 30 to 60 percent slopes, 5.5 miles east of Acme, 1,000 feet north and 1,500 feet west of the southeast corner of sec. 7, T. 37 N., R. 6 E.

Oa-6 inches to 0; decomposed needles, leaves, and twigs; many very fine, fine, medium, and coarse roots.

E1-0 to 3 inches; dark brown (7.5YR 4/2) very channery loam, pinkish gray (7.5YR 7/2) and light gray (10YR 7/1) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine irregular pores; about 35 percent channers; extremely acid; clear smooth boundary.

E2-3 to 6 inches; reddish brown (5YR 5/3) very channery silt loam, pinkish gray (5YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine irregular pores; about 40 percent channers; extremely acid; abrupt smooth boundary.

Bhs-6 to 9 inches; strong brown (7.5YR 5/6) very channery silt loam, brownish yellow (10YR 6/6) dry; dark reddish brown (5YR 2/2) organic stains, very dark gray (5YR 3/1) dry; massive; hard; very firm, nonsticky and nonplastic; weakly smeary; many very fine irregular pores; about 50 percent channers; NaF pH 11.0; very strongly acid; clear smooth boundary.

Bs1-9 to 18 inches; yellowish brown (10YR 5/6) very channery silt loam, brownish yellow (10YR 6/6) dry; dark reddish brown (5YR 2/2) organic stains, dark

reddish brown (5YR 3/2) dry; massive; very hard, very firm, nonsticky and nonplastic; weakly smeary; common very fine irregular pores; about 55 percent channers; NaF pH 12.0; strongly acid; clear smooth boundary.

Bs2-18 to 24 inches; yellowish brown (10YR 5/4) very channery silt loam, light yellowish brown (10YR 6/4) dry; dark reddish brown (5YR 2/2) organic stains, dark reddish brown (5YR 3/2) dry; weak fine subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; weakly smeary; many very fine irregular pores; about 60 percent channers; NaF pH 12.0; very strongly acid; clear smooth boundary.

R-24 inches; phyllite.

The depth to phyllite is 20 to 40 inches. The content of hard phyllite rock fragments in the particle-size control section ranges from 40 to 60 percent.

The E 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 1 to 3 when moist and dry.

The Bhs 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 4 to 6 when moist and dry. It is very channery loam or very channery silt loam.

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 and dry. It is very channery loam or very channery silt loam.

Some pedons have a C horizon. This 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 and dry. It is very channery loam or extremely channery loam.

#### **Cupples Series**

The Cupples series consists of moderately deep, moderately well drained soils formed in a mixture of volcanic ash and loess over glacial till. These soils are on mountain back slopes and plateaus. Slopes are 5 to 60 percent. The average annual precipitation is 60 to 80 inches, and the mean annual air temperature is about 44 degrees F.

These soils are loamy-skeletal, mixed, frigid Typic Haploorthods.

Typical pedon of Cupples gravelly loam, 5 to 30 percent slopes, 5 miles northeast of Deming, 2,200 feet north and 2,400 feet west of the southeast corner of sec. 23, T. 39 N., R. 5 E.

Oi-7 to 5 inches; undecomposed needles and twigs. Oa-5 inches to 0; decomposed forest litter; many very fine, fine, medium, and coarse roots.

E-0 to 2 inches; dark brown (7.5YR 4/2) gravelly fine sandy loam, pinkish gray (7.5YR 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine and fine, common medium, and few coarse roots; common very fine irregular pores; about 15 percent pebbles and 5 percent cobbles; very strongly acid; abrupt smooth boundary.

Bhs-2 to 5 inches; dark brown (7.5YR 3/4) and dark yellowish brown (10YR 3/4) gravelly silt loam, strong brown (7.5YR 5/6) and light yellowish brown (10YR 6/4) dry; dark reddish brown (5YR 3/2) organic stains, dark reddish brown (5YR 3/3) dry; moderate medium and coarse subangular blocky structure; hard, very firm, nonsticky and nonplastic; weakly smeary; common fine and medium roots; common very fine irregular pores; about 20 percent hard pebbles, 20 percent soft pebbles, and 5 percent cobbles; strongly acid; abrupt smooth boundary.

Bs-5 to 10 inches; dark brown (7.5YR 3/4) gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and common medium and coarse roots; many very fine irregular pores; about 10 percent hard pebbles, 30 percent soft pebbles, and 5 percent cobbles; moderately acid; clear wavy boundary.

BC1-10 to 21 inches; olive brown (2.5Y 4/4) very gravelly loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and few medium and coarse roots; many very fine irregular pores; about 30 percent hard pebbles, 25 percent soft pebbles, and 5 percent cobbles; slightly acid; abrupt wavy boundary.

BC2-21 to 30 inches; dark yellowish brown (10YR 4/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine and medium roots; many very fine irregular pores; about 40 percent hard pebbles; slightly acid; abrupt smooth boundary.

2Cd-30 to 60 inches; light olive brown (2.5Y 5/4), dense glacial till that breaks to very gravelly sandy loam, pale yellow (2.5Y 7/4) dry; hard, friable, nonsticky and nonplastic; about 45 percent hard pebbles, 15 percent soft pebbles, and 5 percent cobbles; slightly acid.

The depth to dense, compact glacial till is 20 to 40 inches. The content of rock fragments in the particle-

size control section ranges from 35 to 45 percent hard pebbles, 5 to 25 percent soft pebbles, and 0 to 5 percent cobbles.

The E horizon has hue of 7.5YR or 10YR and value of 3 or 4 when moist and 6 or 7 when dry.

The Bhs and Bs horizons have 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 and dry. They are gravelly loam or gravelly silt loam.

The BC horizon has hue of 10YR or 2.5Y and value of 4 or 5 when moist and 5 or 6 when dry.

The 2Cd horizon has value of 4 or 5 when moist and 6 or 7 when dry. It is dense glacial till that breaks to very gravelly loam or very gravelly sandy loam.

### Dekapen Series

The Dekapen series consists of moderately deep, moderately well drained soils formed in a mixture of volcanic ash and loess over glacial till derived from sandstone. These soils are on mountain plateaus and back slopes. Slopes are 8 to 25 percent. The average annual precipitation is 60 to 75 inches, and the mean annual air temperature is about 44 degrees F.

These soils are coarse-loamy, mixed, frigid Typic Haplorthods.

Typical pedon of Dekapen loam, 8 to 25 percent slopes, 2 miles southeast of Van Zandt, 1,700 feet north and 2,400 feet west of the southeast corner of sec. 15, T. 38 N., R. 5 E.

Oi-1 to 0.25 inch; undecomposed needles, leaves, and twigs.

Oa-0.25 inch to 0; decomposed forest litter; many medium roots.

E-0 to 2 inches; dark brown (7.5YR 3/2) gravelly silt loam, pinkish gray (7.5YR 6/2) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many fine and medium roots; many fine irregular pores; about 10 percent soft pebbles and 15 percent hard pebbles; strongly acid; abrupt wavy boundary.

Bhs-2 to 8 inches; dark brown (7.5YR 3/4) loam, light brown (10YR 6/4) dry; dark reddish brown (5YR 3/2) organic stains, dark brown (7.5YR 4/4) dry; weak fine and medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; weakly smeary; many very fine and medium roots; common fine irregular pores; about 40 percent soft pebbles, 10 percent soft cobbles, and 5 percent hard pebbles; strongly acid; clear wavy boundary.

Bs1-8 to 18 inches; yellowish brown (10YR 5/4) loam, very pale brown (10YR 7/4) dry; weak medium

subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; weakly smeary; many very fine and fine and few medium roots; many fine irregular pores; about 25 percent soft pebbles and 10 percent hard pebbles; strongly acid; clear wavy boundary.

Bs2-18 to 24 inches; dark yellowish brown (10YR 3/4) loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; weakly smeary; many very fine and fine roots; many medium irregular and common medium tubular pores; about 30 percent soft pebbles and 5 percent hard pebbles; strongly acid; clear smooth boundary.

2C-24 to 31 inches; olive brown (2.5Y 4/4) loam, pale yellow (2.5Y 7/4) dry; common fine distinct dark brown (7.5YR 4/4) mottles, brown (7.5YR 5/4) dry; massive; soft, friable, nonsticky and nonplastic; common very fine and many fine and medium irregular and common fine tubular pores; about 30 percent soft pebbles and 5 percent hard pebbles; strongly acid; abrupt smooth boundary.

2Cd-31 to 60 inches; light olive brown (2.5Y 5/4), dense glacial till that breaks to loam, pale yellow (2.5Y 7/4) dry; common fine prominent strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry; massive; very hard, very firm, nonsticky and nonplastic; few very fine irregular pores; about 15 percent soft pebbles and 5 percent hard pebbles; strongly acid.

The thickness of the solum and of the part of the profile influenced by volcanic ash is 24 to 32 inches. The depth to dense, compact glacial till is 24 to 40 inches. By weighted average, the content of rock fragments in the particle-size control section is 25 to 40 percent soft pebbles, 0 to 15 percent soft cobbles, and 5 to 15 percent hard pebbles.

The E horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 2 or 3 when moist and dry.

The Bhs and Bs horizons have hue of 7.5YR or 10YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist and dry. They are loam or sandy loam.

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 dry. It is loam or sandy loam.

The 2Cd horizon is dense glacial till that breaks to loam or sandy loam. It 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 dry.

## Deming Series

The Deming series consists of very deep, well drained soils formed in a mixture of volcanic ash, slope alluvium, and colluvium over unconsolidated glacial till. The slope alluvium, colluvium, and glacial till are derived from sandstone, conglomerate, metasedimentary rocks, and volcanic rocks. These soils are on mountain back slopes. Slopes are 5 to 60 percent. The average annual precipitation is 80 to 95 inches, and the mean annual air temperature is about 40 degrees F.

These soils are loamy-skeletal, mixed Humic Cryorthods.

Typical pedon of Deming gravelly silt loam, 30 to 60 percent slopes, 6 miles northeast of Glacier, 1,900 feet north and 800 feet west of the southeast corner of sec. 10, T. 40 N., R. 6 E.

Oi-4 inches to 1 inch; undecomposed needles, twigs, leaves, wood fragments, and moss.

Oa-1 inch to 0; decomposed needles, twigs, and leaves; many very fine, fine, medium, and coarse roots.

E-0 to 3 inches; dark brown (7.5YR 4/2) gravelly silt loam, pinkish gray (7.5YR 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine and fine and common medium and coarse roots; many very fine irregular pores; about 20 percent pebbles and 5 percent cobbles; extremely acid; abrupt smooth boundary.

Bhs-3 to 8 inches; dark reddish brown (5YR 3/4) gravelly silt loam, yellowish red (5YR 4/6) dry; dark reddish brown (5YR 2/2) organic stains on faces of peds, dark brown (7.5YR 3/3) dry; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many fine and common very fine, medium, and coarse roots; common very fine irregular pores; about 20 percent pebbles and 5 percent cobbles; NaF pH less than 9.0; very strongly acid; abrupt smooth boundary.

Bs1-8 to 15 inches; strong brown (7.5YR 4/6) very gravelly loam, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many fine and medium and common very fine and coarse roots; common very fine irregular pores; about 35 percent pebbles and 5 percent cobbles; NaF pH 11.5; strongly acid; clear wavy boundary.

Bs2-15 to 24 inches; dark brown (7.5YR 4/4) very gravelly sandy loam, yellowish brown (10YR 5/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few

medium roots; common very fine irregular pores; about 45 percent pebbles and 10 percent cobbles; NaF pH 11.5; very strongly acid; clear wavy boundary.

BC-24 to 37 inches; dark yellowish brown (10YR 3/4) extremely gravelly sandy loam, dark yellowish brown (10YR 4/4) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few medium roots; many very fine irregular pores; about 50 percent pebbles, 10 percent cobbles, and 5 percent stones; NaF pH 11.0; very strongly acid; clear smooth boundary.

2C-37 to 60 inches; dark yellowish brown (10YR 4/4) extremely gravelly loamy sand, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine roots; many fine irregular pores; about 60 percent pebbles and 5 percent cobbles; NaF pH 10.5; strongly acid.

The thickness of the part of the profile influenced by volcanic ash is more than 40 inches. The thickness of the solum is 24 to 40 inches. The content of rock fragments in the control section ranges from 45 to 60 percent.

The E horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 or 3 when moist and dry.

The Bhs horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist and 3 to 5 when dry, and chroma of 4 to 6 when moist and dry.

The Bs and BC horizons have hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 to 6 when moist and dry. They are very gravelly loam, very gravelly sandy loam, or extremely gravelly sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 6 when moist and dry. It is very gravelly loam, very gravelly sandy loam, or extremely gravelly loamy sand.

## Diobsud Series

The Diobsud series consists of moderately deep, moderately well drained soils formed in a mixture of volcanic ash and colluvium over glacial till derived from phyllite. These soils are on mountain back slopes and ridges. Slopes are 30 to 60 percent. The average annual precipitation is 85 to 95 inches, and the mean annual air temperature is about 42 degrees F.

These soils are coarse-loamy, mixed Humic Cryorthods.

Typical pedon of Diobsud gravelly silt loam, 30 to 60 percent slopes, 9.5 miles east of Wickersham, 2,600

feet south and 100 feet east of the northwest corner of sec. 35, T. 37 N., R. 6 E.

Oa-7 to 3 inches; undecomposed needles, leaves, and twigs.

Oi-3 inches to 0; decomposed needles, leaves, and twigs; many very fine and fine and few medium roots.

E-0 to 4 inches; dark brown (7.5YR 3/2) gravelly silt loam, pinkish gray (7.5YR 6/2) dry; massive; soft, friable, nonsticky and nonplastic; common very fine, fine, and medium roots; many very fine irregular pores; about 30 percent pebbles; extremely acid; abrupt smooth boundary.

Bhs-4 to 11 inches; dark brown (7.5YR 3/4) gravelly silt loam, brown (7.5YR 5/4) dry; reddish brown (5YR 5/4) organic stains, light reddish brown (5YR 6/4) dry; moderate coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few medium roots; many very fine irregular pores; about 30 percent pebbles; NaF pH 10.0; very strongly acid; abrupt irregular boundary.

Bs-11 to 16 inches; strong brown (7.5YR 4/6) gravelly silt loam, reddish yellow (7.5YR 6/6) dry; moderate coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine, fine, and medium roots; many very fine irregular pores; about 25 percent pebbles; NaF pH 12.0; strongly acid; clear irregular boundary.

BC-16 to 20 inches; brown (10YR 5/3) gravelly silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine and fine roots; many very fine irregular pores; about 30 percent pebbles; NaF pH 12.0; strongly acid; clear smooth boundary.

C-20 to 37 inches; olive gray (5Y 5/2) gravelly loam, light olive gray (5Y 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; very few very fine roots; common very fine irregular pores; about 30 percent pebbles; NaF pH 12.0; strongly acid; abrupt smooth boundary.

2Cd-37 to 60 inches; olive gray (5Y 4/2), dense glacial till that breaks to very gravelly loam, light olive gray (5Y 6/2) dry; massive; hard, firm, nonsticky and nonplastic; about 45 percent pebbles; NaF pH 12.0; strongly acid.

The depth to dense, compact glacial till is 20 to 40 inches. The particle-size control section ranges from 20 to 35 percent hard phyllite fragments.

The E horizon has hue of 7.5YR or 10YR, value of 3

to 5 when moist and 6 to 8 when dry, and chroma of 1 or 2 when moist and dry.

The Bhs and Bs horizons have 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 and dry. They are gravelly loam or gravelly silt loam.

The BC horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 2 or 3 when moist and dry. It is gravelly loam or gravelly silt loam.

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 and dry. It is gravelly loam or gravelly clay loam.

The 2Cd horizon is dense glacial till that breaks to gravelly loam or very gravelly loam. It 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 and dry.

### Edfro Series

The Edfro series consists of shallow, moderately well drained soils formed in a mixture of volcanic ash, loess, and colluvium over glacial till derived from dunite. These soils are on high mountain shoulder slopes and back slopes. Slopes are 8 to 60 percent. The average annual precipitation is 85 to 105 inches, and the mean annual temperature is about 41 degrees F.

These soils are loamy-skeletal, serpentinitic, shallow Typic Cryorthods.

Typical pedon of Edfro very gravelly silt loam, 30 to 60 percent slopes, 7 miles east of Acme, 1,700 feet south and 1,700 feet east of the northwest corner of sec. 4, T. 37 N., R. 6 E.

Oi-4 to 3.5 inches; needles, leaves, and twigs.

Oa-3.5 inches to 0; decomposed needles, twigs, and bark; many very fine and common fine roots.

E-0 to 3 inches; brown (7.5YR 5/2) very gravelly silt loam, pinkish gray (7.5YR 7/2) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; about 30 percent pebbles and 5 percent cobbles; NaF pH 10.0; extremely acid; abrupt wavy boundary.

Bhs1-3 to 7 inches; strong brown (7.5YR 4/6) very gravelly silt loam, strong brown (7.5YR 5/8) dry; dark reddish brown (2.5YR 3/4) organic stains on faces of peds, yellowish red (5YR 4/6) dry; moderate medium and coarse subangular blocky structure; hard, very firm, nonsticky and nonplastic; weakly smeary; common very fine roots; many very fine irregular pores; about 45 percent pebbles and

10 percent cobbles; NaF pH 11.5; very strongly acid; clear wavy boundary.

Bhs2-7 to 17 inches; yellowish red (5YR 4/6) extremely gravelly silt loam, yellowish red (5YR 5/6) dry; dark reddish brown (2.5YR 3/4) organic stains on faces of peds, reddish brown (5YR 4/4) dry; moderate medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; weakly smeary; few very fine roots; common very fine irregular pores; about 50 percent pebbles and 10 percent cobbles; NaF pH 12.0; very strongly acid; clear wavy boundary.

Bhs3-17 to 19 inches; dark brown (7.5YR 4/4) extremely gravelly loam, strong brown (7.5YR 4/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; very few very fine roots; many fine irregular pores; about 60 percent pebbles; NaF pH 12.0; very strongly acid; abrupt wavy boundary.

2Cd-19 to 60 inches; light yellowish brown (2.5Y 6/4), dense compact glacial till that breaks to very gravelly loam, light gray (2.5Y 7/2) dry; massive; extremely hard, very firm, nonsticky and nonplastic; weakly smeary; about 40 percent pebbles; NaF pH 10.5; very strongly acid.

The depth to dense, compact glacial till ranges from 14 to 20 inches. The content of rock fragments in the control section ranges from 40 to 60 percent, which includes 5 to 10 percent cobbles.

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 2 or 3 when moist and 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 4 to 6 when moist and 6 to 8 when dry. It is very gravelly loam or very gravelly silt loam.

The 2Cd horizon is dense, compact glacial till. It has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 4 to 7 when dry, and chroma of 2 to 4 when moist and 1 to 4 when dry. It is dense glacial till that breaks to very gravelly loam, very gravelly sandy loam, or very gravelly loamy sand.

### Edmonds Series

The Edmonds series consists of very deep, somewhat poorly drained soils formed in an admixture of loess and volcanic ash over glacial outwash. These soils are on outwash terraces and outwash plains. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy over sandy or sandy

skeletal, mixed, mesic, ortstein Typic Sideraquods.

Typical pedon of Edmonds loam, in an area of Edmonds-Woodlyn loams, drained, 0 to 2 percent slopes; 3 miles north of Ferndale, 1,200 feet south and 1,900 feet east of the northwest corner of sec. 8, T. 39 N., R. 2 E.

Ap1-0 to 6 inches; dark brown (7.5YR 3/2) loam, pinkish gray (7.5YR 6/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine irregular pores; NaF pH 9.9; moderately acid; clear smooth boundary.

Ap2-6 to 11 inches; dark brown (7.5YR 4/2) loam, pinkish gray (7.5YR 7/2) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine irregular pores; NaF pH 10.4; moderately acid; abrupt smooth boundary.

E-11 to 18 inches; dark grayish brown (10YR 4/2) loam, light gray (10YR 7/2) dry; moderate medium subangular blocky structure; hard, firm, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; NaF pH 11.0; moderately acid; abrupt smooth boundary.

2Bs-18 to 23 inches; dark brown (10YR 3/3) loamy sand, pale brown (10YR 6/3) dry; many coarse prominent dark yellowish brown (10YR 3/6) mottles, reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; NaF pH 11.1; moderately acid; abrupt smooth boundary.

2Bsm-23 to 37 inches; yellowish red (5YR 4/6 and 5/6) loamy sand, reddish yellow (5YR 6/6 and 7.5YR 6/6) dry; 75 percent ortstein concretions 2 to 6 inches in diameter; many coarse prominent dark brown (10YR 4/3) mottles, very pale brown (10YR 7/3) dry; massive; extremely hard ortstein and slightly hard matrix; extremely firm ortstein and friable matrix; nonsticky and nonplastic; few fine irregular pores in matrix; NaF pH 10.7; moderately acid; abrupt smooth boundary.

2C-37 to 60 inches; sand that is dominantly dark grayish brown (2.5Y 4/2) but is variegated; light brownish gray (2.5Y 6/2) dry; single grain; loose; many fine irregular pores; about 5 percent pebbles; NaF pH 9.9; slightly acid.

The thickness of the solum is 20 to 40 inches. The thickness of the loamy part of the solum is 14 to 20 inches. The particle-size control section is 0 to 5 percent pebbles by weighted average.

The Ap horizon has hue of 7.5YR or 10YR, value of

3 or 4 when moist and 6 or 7 when dry, and chroma of 1 to 3 when moist and dry. Reaction is strongly acid or moderately acid. Pedons in uncultivated areas have an A horizon. This horizon is 3 to 7 inches thick and is similar to the Ap horizon.

The E horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist and dry. It is loam or sandy loam.

The 213s horizon has hue of 7.5YR or 10YR in the matrix and 5YR or 7.5YR in the ortstein or mottles. It has value of 3 to 5 when moist and 5 to 7 when dry. It has chroma of 2 to 4 when moist and dry in the matrix and 4 to 6 in the ortstein or mottles. It is loamy sand or sand. It has a subhorizon that is 50 to 80 percent ortstein occurring as rounded or angular concretions, slaglike fragments, or irregularly shaped indurated accretions. This horizon is at least 5 inches thick.

The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 or 4 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist and dry. It is coarse sand or sand.

### Eliza Series

The Eliza series consists of very deep, very poorly drained soils formed in alluvium. These soils are on flood plains, deltas, and tidal flats. Slopes are 0 to 1 percent. The average annual precipitation is about 30 to 40 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy, mixed, acid, mesic Sulfic Fluvaquents.

Typical pedon of Eliza silt loam, drained, 0 to 1 percent slopes, 3 miles southwest of Ferndale, 1,200 feet north and 1,200 feet east of the southwest corner of sec. 6, T. 38 N., R. 2 E.

Ap-0 to 11 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) silt loam, light brownish gray (2.5Y 6/2) and light gray (10YR 7/2) dry; moderate medium granular structure; very hard, friable, slightly sticky and plastic; many very fine and fine roots; many very fine irregular pores; moderately acid when moist and strongly acid when dry; abrupt smooth boundary.

Cg1-11 to 15 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) and light gray (2.5Y 7/2) dry; common medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; very hard, friable, slightly sticky and plastic; many very fine and fine irregular pores; strongly acid when moist and very strongly acid when dry; abrupt smooth boundary.

Cg2-15 to 19 inches; gray (5Y 5/1) fine sandy loam,

light gray (5Y 6/1) dry; many coarse prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; many very fine irregular pores; very strongly acid when moist and dry; abrupt smooth boundary.

Cg3-19 to 24 inches; dark gray (N 4/0) fine sandy loam, gray (N 6/0) dry; many medium prominent dark yellowish brown (10YR 4/6) mottles, yellowish brown (10YR 5/6) dry; massive; soft, very friable, nonsticky and slightly plastic; common very fine and fine and few medium roots; many very fine irregular pores; very strongly acid when moist and dry; clear smooth boundary.

Cg4-24 to 34 inches; stratified dark gray (5Y 4/1) silt loam, gray (N 5/0) fine sandy loam, and strong brown (7.5YR 5/8) sand, gray (N 5/0), light gray (N 6/0), and strong brown (7.5YR 5/8) dry; massive in silt loam and fine sandy loam and single grain in sand; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and common fine irregular pores; very strongly acid when moist and extremely acid when dry; clear smooth boundary.

Cg5-34 to 44 inches; stratified dark grayish brown (2.5Y 4/2) silt loam, dark gray (5Y 4/1) fine sandy loam, and yellowish brown (10YR 5/6) sand, light brownish gray (2.5Y 6/2), light gray (N 7/0), and brownish yellow (10YR 6/6) dry; massive in silt loam and fine sandy loam and single grain in sand; soft, very friable, nonsticky and nonplastic; very few very fine roots; very strongly acid when moist and extremely acid when dry; abrupt smooth boundary.

Cg6-44 to 52 inches; stratified dark gray (5Y 4/1) silt loam and fine sandy loam and dark yellowish brown (10YR 4/6) sand, light gray (N 6/0 and N 7/0) and yellowish brown (10YR 5/6) dry; massive in silt loam and fine sandy loam and single grain in sand; soft, very friable, nonsticky and nonplastic very strongly acid when moist and extremely acid when dry; abrupt smooth boundary.

Cg7-52 to 60 inches; stratified dark gray (N 4/0) silt loam and fine sandy loam and yellowish brown (10YR 5/8) sand, gray (N 5/0 and N 6/0) and brownish yellow (10YR 6/8) dry; massive in silt loam and fine sandy loam and single grain in sand; soft, very friable, nonsticky and nonplastic; neutral when moist and strongly acid when dry.

The 10- to 40-inch particle-size control section ranges from 10 to 18 percent clay. These soils have an irregular distribution of organic matter with increasing depth.

reduce the degree of soil compaction and displacement. In areas where the soils have a high content of phyllite, greater care is needed in the design and construction of roads and in the selection of harvesting equipment.

Many of the wood products produced in the survey area are transported to processing facilities outside of the area. Much of the wood for pulp is used locally at a large pulp and paper mill. Other processors in the area include a few shake and shingle mills, one plywood and veneer mill, four softwood lumber mills, and one outlet for posts, poles, and pilings. Red alder wood products are generally transported out of the survey area for processing.

A demand for urban and industrial development sites exists in the survey area. Total commercial woodland acreage may decline in the area as pressure to convert to other uses increases, but loss of productive acres may be partially offset by intensive management practices.

A statistical analysis was used in obtaining the woodland site data in this survey. Data from forest tree sites were taken by a forester. When a prospective tree stand on a particular map unit was identified by the forester, five site trees, generally the dominant trees on the site, were selected. Tree height, diameter at breast height, and breast-height age were determined. All ground vegetation also was identified and recorded on a data card (39).

On the basis of a 100-year site curve, the mean site index for the five trees was calculated by adjusting the breast-height age to total age for Douglas fir (28) and western hemlock (4). On the basis of a 50-year site curve, the mean site index was calculated directly from average breast-height age and total tree height for Douglas fir (22) and western hemlock (47). The site index for red alder was calculated in the same manner using average age at breast-height and total height (49). A statistical analysis of all site indices for each soil series or map unit was conducted. Standard deviation, standard error of the mean, and coefficient of variation were calculated (38).

All of the site data for a particular series was analyzed initially to obtain a coefficient of variation of less than 8 percent. If the 8 percent threshold was exceeded, then the site data applicable to each map unit within the series was analyzed in the same manner. If a 5 foot or more difference in site indices existed between map units, then those calculated site indices were used. If the difference was less than 5 feet and the coefficient of variation was less than 8 percent, the site indices were averaged for the series. For series without adequate site data, an estimated site index was established using data gathered for similar soils (45).

Soil surveys are becoming increasingly more

important to forest managers as they seek ways of increasing the productivity of their forested lands. Plants respond better to applications of fertilizers on some soils than on others. Some soils are more susceptible to landslides and erosion after road building and harvesting, and others require special effort to harvest and reforest.

Each description of the map units suitable for producing wood crops includes information about forest productivity, timber production, limitations affecting timber harvesting, and common forest understory plants. The methods and procedures used to develop the information for the map units are described in the *National Forestry Manual* (45) and the *Forest Land Grading Procedures Handbook* (39).

Table 8 summarizes forestry information given in the map unit descriptions and can serve as a quick reference for important forestry interpretations. Map unit symbols are listed, and the ordination (woodland suitability) symbol for each map unit in the table is given. All soils having the same ordination symbol require the same general kinds of forest management and have about the same potential productivity.

The *ordination symbol* is based on a uniform system that indicates the potential productivity of an individual soil and the principal hazards or limitations of that soil. The first element of the ordination symbol is a number that denotes the potential productivity in terms of cubic meters of wood per hectare per year for the indicator tree species. The potential productivity is based on the site index and the corresponding culmination of the mean annual increment. For example, the number 1 indicates a potential production of 1 cubic meter of wood per hectare (14.3 cubic feet per acre) per year and 10 indicates a potential production of 10 cubic meters of wood per hectare (143 cubic 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 stoniness or rockiness; *W*, excessive water, either seasonally or year round, in or on the soil; *T* toxic substances within the root zone; *D*, restricted rooting depth; *C*, clayey soils; *S*, sandy soils; *F*, fragmented or skeletal soils with coarse fragments that are more than 2 millimeters and less than 10 inches in size; and *R*, relief or slope. The letter *A* indicates no or only slight limitations affect use and management. If a soil has more than one limitation, the letter denoting the most limiting characteristic is used.

The number designation of the ordination symbol also represents the productivity class. Productivity class is calculated for other important common trees on the soil for which a site index has been provided. This

figure denotes potential productivity in terms of cubic meters of wood per hectare per year.

In table 8 the soils also are rated for a number of factors to be considered in management. Ratings of *slight*, *moderate*, and *severe* are used to indicate the degree of major soil limitations. For each moderate or severe rating, a sentence in the applicable map unit description explains the soil factor or factors that are the basis of that rating.

Ratings of *erosion hazard* indicate the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Ratings of the *equipment limitation* reflect the soil characteristics and conditions that restrict the use of equipment, either year round or seasonally. A rating of *slight* indicates that the use of equipment is not normally restricted to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation because of soil wetness, a fluctuating water table, or some other factor; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment. Slope and wetness are the main factors that cause equipment limitations. As slope gradient and length increase, using wheeled equipment becomes more difficult. On the steeper slopes, tracked equipment must be used. On the steepest slopes, even tracked equipment cannot be operated safely and more sophisticated systems must be used. Wetness, especially in combination with fine texture, can severely limit the use of equipment, making harvesting practical only during dry summer months.

Ratings of *seedling mortality* indicate the probability of the 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 naturally established seedlings that germinate during a period of insufficient soil moisture. A rating of *slight* indicates that no significant mortality is expected under usual conditions; *moderate* indicates that some mortality can be expected and that extra precautions are advisable; and *severe* indicates that mortality will be high and

extra precautions are essential for successful reforestation. Seedling mortality can be caused by wetness; by droughtiness in the surface layer, especially on south- or southwest-facing slopes; or by the position of the soil on a ridgetop. To offset these, larger than usual planting stock, special site preparation, a surface drainage system, or reinforcement planting may be needed.

Ratings of *windthrow hazard* are based on 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 normally are not blown down by the wind. Strong winds may break the trees but do not uproot them. A rating of *moderate* indicates that an occasional tree may be blown down during periods of excessive wetness and moderate or strong winds, and a rating of *severe* indicates that many trees are expected to be blown down during these periods. A restricted rooting depth caused by a high water table, underlying bedrock, and an impervious layer or poor anchoring of roots because of a loose surface layer and subsoil are responsible for windthrow. Moderate and severe ratings indicate the need for more care in thinning the edges of woodland stands, a plan calling for periodic removal of windthrow trees, and an adequate road and trail system to allow for this removal.

Ratings of *plant competition* indicate the likelihood of the invasion or growth of undesirable brushy plants when openings are made in the tree canopy. A rating of *slight* indicates that unwanted brushy plants are not likely to delay natural reforestation and that planted seedlings can survive and grow well 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. In many areas the key to predicting brush competition is the quantity and proximity of seed sources of undesirable plants or the quantity of unwanted bush rootstocks that will resprout after harvest activities. Moderate and severe ratings indicate the need for careful and thorough cleanup after harvest in preparation for reforestation and the possible need for mechanical or chemical treatment to retard the growth of brush and allow seedlings to become established.

The *potential productivity* of common trees on a soil is expressed as a *site index* and a *productivity class*. The site index is determined by measuring the height and age of selected trees within stands of a given species (4, 22, 28, 47, 49). It applies to fully stocked, even-aged, unmanaged stands. The greatest timber yields, usually expressed in board feet or cubic feet per

acre, can be expected from map units with the highest site index values. These values can be converted into estimated yields at various ages by carefully using appropriate yield publications (4, 9, 10, 28, 48, 49).

*Common trees* are listed in the same order as that of their general occurrence observed on the map unit. Generally, only one or two species will predominate.

*Trees to plant* are those that are planted for reforestation or that, under suitable conditions, are allowed to regenerate naturally. The species listed in table 8 are suited to the soils and can be used for commercial wood production. The desired product, the topographic position (such as a ridgetop), and personal preference are three of many factors that can influence the choice of suitable trees to use for reforestation.

## Windbreaks and Environmental Plantings

Dennis J. Robinson, area forester, Soil Conservation Service, helped to prepare this section.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Most of the lowland soils in the survey area were originally forested. A large portion of the native vegetation, however, has been cleared for farms and towns. In the north-central and northeast parts of the lowland area, between the towns of Everson and Sumas, windbreaks protect farm buildings and houses from northeast winds. Weather systems moving southwest from the Fraser River Valley of Canada bring snow and cold, desiccating winds to the area. As a result, windbreaks are needed for protection. Windbreaks and environmental plantings can be established. Measures that maintain them are needed. Plantings can include a single species or a variety of species.

The most effective arrangement of windbreak plantings consists of dense, low-growing shrubs in the windward rows, taller deciduous trees or shrubs in the center row or rows, and evergreen trees or shrubs on the leeward side (44). Such an arrangement makes the windbreak more effective in winter. If only one or two rows are planted, species that provide maximum protection should be selected. For example, if protection of a large area is needed, tall trees should be planted, or if control of ground winds is needed, dense shrubs or evergreens are most effective. Generally, wind movement on the leeward side of the planting is effectively reduced to a distance equal to 10 to 20 times the height of the windbreak.

Plants suitable for windbreaks and environmental

plantings in the survey area have not been tested. Many windbreaks that are installed consist primarily of adapted native species of deciduous trees and shrubs and coniferous trees. Lombardy poplar is the most suitable deciduous tree. Douglas fir, Rocky Mountain juniper, western redcedar, ponderosa pine, and grand fir are the most commonly used evergreen species. Native and adapted shrub species, such as willows and common lilac, are suitable for use in the low-growing shrub row in the windbreak plantings. Generally, adequate moisture for growth is provided by normal precipitation. Irrigation may be necessary, however, on the drier sites in late August and September.

The spacing between rows and between the trees and shrubs in the rows is important. Deciduous trees should be spaced at least 12 feet apart in the row, shrubs should be 3 or 4 feet apart, and evergreen trees should be at least 6 feet apart. The rows of trees should be 12 to 18 feet apart. The size of the cultivating equipment is a consideration in row-to-row spacing.

Other aspects of layout are equally important. Farmstead windbreaks should be at least 100 feet from the buildings so that air can move on hot days. Rounded corners are easier to cultivate than square ones. Areas to be planted should be free of vegetation before the trees or shrubs are planted.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a local nursery.

## Recreation

Whatcom County has many areas of scenic, recreational, geologic, and historic interest. These areas are used for camping, hiking, hunting, fishing, sightseeing, mountain climbing, bicycling, picnicking, and boating. Public areas available for recreation within the survey area include eight county parks, three state parks, a state game range, and several fish hatcheries.

Important marine features include Lummi and Eliza Islands, Point Francis, Bellingham Bay, numerous beaches, and scenic Chuckanut Drive, which follows the water's edge south of Bellingham. The western boundary of Mount Baker National Forest is the eastern boundary of the survey area. Lake Whatcom, Lake Samish, the Nooksack River, and the Strait of Georgia

are prime fishing areas. Mount Baker and Twin Sisters Mountain, immediately east of the survey area, are important recreational areas.

The soils of the survey area are rated in table 9 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 sewer lines. 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 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

*Camp areas* require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

*Picnic areas* are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

*Playgrounds* require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

*Paths and trails* for hiking 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

The survey area contains a wide variety of habitat types ranging from salt water to alpine mountain peaks, which support a variety of wildlife. Approximately three-fourths of the survey area on the western slope of the Cascade Range is covered by coniferous forests. Numerous rocky peaks, which are above 8,000 feet, provide a home for species characteristic of these alpine environments. These species include pika, white-tailed ptarmigan, and mountain goat.

The western one-fourth of the survey area consists of lowlands and relatively flat terrain, which is used mainly for agriculture. Agricultural land is interspersed with numerous remnant patches of coniferous forest and riparian woodland. These small wooded areas support woodland wildlife and provide cover for openland wildlife. The lowlands contain numerous wetlands, sloughs, and creeks, which provide important habitat for fish, waterfowl, and other aquatic and wetland wildlife.

Much of the survey area is drained by the Nooksack River, which flows into Bellingham Bay. About 650 rivers and streams are in the Nooksack drainage system, which includes about 1,300 miles of streams and tributaries. Bald eagles concentrate along the river in winter to feed on the salmon, steelhead, and cutthroat trout that migrate upstream each year. In an average year, about 55,000 adult salmon return to spawn in the Nooksack drainage system.

Bellingham, Lummi, Chuckanut, and Birch Bays provide habitat for saltwater fish and shellfish. An

abundance of marine invertebrates and aquatic vegetation attract large resident and wintering populations of loons, grebes, cormorants, herons, ducks, shorebirds, gulls, ferns, and black brants.

Soils and climate 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 10, 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, brome grass, 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, 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, available water capacity, and wetness. Examples of these plants are red alder, bigleaf maple, Pacific dogwood, cottonwood, vine maple, and willow. Examples of fruit-producing trees and shrubs that are suitable for planting on soils rated *good* are blackberry, apple, cherry, crabapple, and mountain ash.

*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, Oregon grape, and salmonberry.

*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. Wildlife attracted to these areas include California quail, pheasant, mourning dove, meadowlark, chipping sparrow, and brush rabbit.

*Habitat for woodland wildlife* consists of areas of deciduous and coniferous plants and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include blue and ruffed grouse, thrushes, woodpeckers, squirrels, Cascade red fox, mountain goat, ptarmigan, 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 or 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 evaluate the potential of areas for residential, commercial, industrial, and recreation uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

## Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

*Shallow excavations* are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging,

filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and 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, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

*Local roads and streets* have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

*Lawns and landscaping* require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

### **Sanitary Facilities**

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations

are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 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 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

*Sanitary landfills* are areas where solid waste is disposed of by burying it in soil. There are two types of landfill-trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 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 13 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 to 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, a 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 a 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 depth to the water table is less than 1 foot. These soils 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 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

*Topsoil* is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils

are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

## Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

*Pond reservoir areas* hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

*Embankments, dikes, and levees* are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable

compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

*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 control 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

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Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, 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 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

*Depth* to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

*Texture* is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52

percent sand. If 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 Unified soil classification system (2) and the system adopted by the American Association of State Highway and Transportation Officials (1). Both systems are described in the *PCA Soil Primer* (33).

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, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

*Rock fragments* larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

*Percentage (of soil particles) passing designated sieves* is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and

in nearby areas and on estimates made in the field.

*Liquid limit* and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally 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 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

*Clay* as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

*Moist bulk density* is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

*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.

*Salinity* is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

*Shrink-swell potential* is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the

change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

*Erosion factor K* indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

*Erosion factor T* is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

*Wind erodibility groups* are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

- 4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay

loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

*Organic matter* is the plant and animal residue in the soil at various stages of decomposition. In table 16, 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 in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

## Soil and Water Features

Tables 17 and 18 give estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

*Hydrologic soil groups* are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the

surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

*Flooding*, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *brief* if less than 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

*High water table* (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 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 commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

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 one by a dry zone.

Only saturated zones within a depth of about 6 feet

are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

*Depth to bedrock* is given in table 18 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 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.

*Cemented pans* are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

*Subsidence* is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 18 shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

*Potential frost action* is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the 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.

Soils in Whatcom County that are below an elevation of approximately 800 feet are not usually subject to potential frost action.

*Risk of corrosion* pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe

corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate, or high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate, or high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

# Classification of the Soils

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The system of soil classification used by the National Cooperative Soil Survey has six categories (43). 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 19 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

**ORDER.** Eleven 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 Spodosol.

**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 Orthod (*Orth*, meaning true, plus *od*, from Spodosol).

**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 Haplorthods (*Hapl*, meaning minimal horizonation, plus *orthod*, a suborder of Spodosols).

**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 *Aqualfic* identifies the subgroup that is saturated with water at some time of the year and has an argillic horizon. An example is Aqualfic Haplorthods.

**FAMILY.** Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Aqualfic Haplorthods.

**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* (41). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (43). 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 formed in a mixture of volcanic ash and loess, over, glacial outwash. These

soils are on outwash terraces and terrace escarpments. Slopes are 0 to 60 percent. The average annual precipitation is 60 to 75 inches, and the mean annual air temperature is about 47 degrees F.

These soils are sandy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Barneston gravelly loam, 0 to 8 percent slopes, 1 mile southeast of Kendall, 2,000 feet north and 1,250 feet west of the southeast corner of sec. 35, T. 40 N., R. 5 E.

Oi-2.5 to 2 inches; undecomposed needles, leaves, and twigs.

Oa-2 inches to 0; decomposed organic mat; many fine and medium roots.

E-0 to 1.5 inches; brown (7.5YR 5/2) gravelly loam, pinkish gray (7.5YR 6/2) dry; weak fine and medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, and medium roots; many fine irregular pores; about 20 percent pebbles; NaF pH 9.4; strongly acid; clear smooth boundary.

Bs1-1.5 to 8 inches; dark brown (7.5YR 3/4) gravelly loam, brown (7.5YR 5/4) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, and medium roots; many fine irregular pores; about 30 percent pebbles; NaF pH 11.0; strongly acid; clear wavy boundary.

Bs2-8 to 14 inches; dark brown (7.5YR 3/4) very gravelly loam, light brown (7.5YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and many fine roots; many fine irregular pores; about 45 percent pebbles; NaF pH 11.5; strongly acid; clear wavy boundary.

2C1-14 to 28 inches; dark yellowish brown (10YR 4/4) extremely gravelly sand, light yellowish brown (10YR 6/4) dry; single grain; loose; many fine and few medium roots; many medium and coarse irregular pores; about 70 percent pebbles and 5 percent cobbles; NaF pH 11.5; strongly acid; clear smooth boundary.

2C2-28 to 40 inches; olive brown (2.5Y 4/4) extremely gravelly sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose; common fine and few medium roots; many medium and coarse subangular pores; about 75 percent pebbles and 5 percent cobbles; moderately acid; clear smooth boundary.

2C3-40 to 60 inches; dark grayish brown (2.5Y 4/2) extremely gravelly sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; few medium roots; many medium and coarse irregular pores; about 70

percent pebbles and 5 percent cobbles; moderately acid.

The thickness of the solum and of the part of the profile influenced by volcanic ash is 13 to 24 inches. The content of clay in the lower part of the particle-size control section is 0 to 3 percent. By weighted average, the upper part of the control section has 35 to 60 percent pebbles and 0 to 10 percent cobbles and the lower part has 45 to 70 percent pebbles, 5 to 15 percent cobbles, and 0 to 15 percent stones.

The E horizon has hue of 7.5YR or 10YR, value of 2 to 5 when moist and 4 to 7 when dry, and chroma of 2 to 4 when moist and dry. Some pedons have an A horizon.

The Bs horizon has hue of 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 dry. It is gravelly loam, gravelly sandy loam, very gravelly loam, or very gravelly sandy loam.

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 2 to 6 when moist and dry. It is very gravelly loamy sand, very gravelly sand, extremely gravelly loamy sand, or extremely gravelly sand.

### **Barnhardt Series**

The Barnhardt series consists of very deep, well drained soils formed in a mixture of volcanic ash, loess, and glacial outwash. These soils are on terraces. Slopes are 0 to 5 percent. The average annual precipitation is about 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

These soils are loamy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Barnhardt gravelly loam, 0 to 5 percent slopes, about 2 miles southwest of Everson, 250 feet south and 1,900 feet west of the northeast corner of sec. 11, T. 39 N., R. 3 E.

Oi-1 inch to 0; undecomposed needles, leaves, and twigs.

A-0 to 3 inches; dark brown (7.5YR 3/2) gravelly loam, brown (10YR 5/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and common fine roots; many very fine irregular pores; about 20 percent pebbles; NaF pH 10.0; slightly acid; clear wavy boundary.

Bs1-3 to 9 inches; dark brown (7.5YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many

very fine and common fine roots; many very fine irregular pores; about 25 percent pebbles; NaF pH 10.5; moderately acid; clear wavy boundary.

Bs2-9 to 21 inches; yellowish brown (10YR 5/4) extremely gravelly loam, very pale brown (10YR 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine, common fine, and few medium roots; many very fine irregular pores; about 60 percent pebbles; NaF pH 10.5; moderately acid; gradual wavy boundary.

BC-21 to 42 inches; yellowish brown (10YR 5/4) extremely gravelly sandy loam, pale yellow (2.5Y 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, medium, and coarse roots; many very fine irregular pores; about 75 percent pebbles; NaF pH 10.5; moderately acid; gradual wavy boundary.

C-42 to 60 inches; yellowish brown (10YR 5/4) extremely gravelly loam, very pale brown (10YR 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few very fine roots; many very fine irregular pores; about 70 percent pebbles; NaF pH 9.6; moderately acid.

The part of the profile influenced by volcanic ash is 60 or more inches thick. The thickness of the solum is 8 to 30 inches. The particle-size control section has 50 to 75 percent pebbles and 0 to 5 percent cobbles by weighted average.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist, and chroma of 2 to 4 when moist and dry.

The Bs horizon has hue of 7.5YR or 10YR and value of 4 or 5 when moist and 6 or 7 when dry. It is gravelly loam, very gravelly loam, very gravelly silt loam, or extremely gravelly loam.

The BC and C horizons have 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 and dry. Within the particle-size control section, they are very gravelly loam, extremely gravelly sandy loam, or very gravelly silt loam. Below the control section, they are extremely gravelly loam, extremely gravelly sandy loam, or extremely gravelly loamy sand.

### **Bellingham Series**

The Bellingham series consists of very deep, poorly drained soils formed in an admixture of loess, alluvium, and lacustrine deposits. These soils are in depressions on terraces. Slopes are 0 to 2 percent. The average

annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

These soils are fine, mixed, nonacid, mesic Mollic Haplaquepts.

Typical pedon of Bellingham silty clay loam, 0 to 2 percent slopes, 1.5 miles north of Everson, 2,200 feet south and 100 feet east of the northwest corner of sec. 19, T. 40 N., R. 4 E.

Ap-0 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; many very fine and fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

Bg1-10 to 18 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 4/3) silty clay loam, grayish brown (10YR 5/2) and pale brown (10YR 6/3) dry; common fine prominent mottles, yellowish brown (10YR 5/6) moist and dry; moderate fine subangular blocky structure; slightly hard, firm, slightly sticky and plastic; common very fine and few fine roots; many very fine irregular pores; few patchy clay films on faces of peds; slightly acid; abrupt smooth boundary.

Bg2-18 to 24 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) silty clay loam, light gray (2.5Y 7/2) and pale yellow (2.5Y 7/4) dry; common medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; weak coarse prismatic structure parting to medium fine subangular blocky; very hard, firm, slightly sticky and plastic; common very fine roots; many very fine irregular pores; neutral; clear smooth boundary.

CB-24 to 30 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; many medium distinct light olive brown (2.5Y 5/4) mottles, light yellowish brown (2.5Y 6/4) dry; moderate medium subangular blocky structure; very hard, firm, slightly sticky and plastic; few very fine roots; common very fine irregular pores; few patchy clay films on faces of peds; neutral; clear smooth boundary.

C1-30 to 38 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (5Y 7/1) dry; common fine prominent light olive brown (2.5Y 5/4) mottles, light yellowish brown (2.5Y 6/4) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, slightly sticky and plastic; few very fine roots; neutral; clear smooth boundary.

C2-38 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, white (2.5Y 8/2) dry; common fine prominent light olive brown (2.5Y 5/4) mottles, light yellowish brown (2.5Y 6/4) dry; moderate coarse prismatic

structure parting to moderate medium subangular blocky; very hard, firm, slightly sticky and plastic; few very fine roots; neutral.

The particle-size control section has 35 to 60 percent clay by weighted average. The thickness of the solum is 10 to 30 inches.

The Ap horizon has value of 2 or 3 when moist and 4 or 5 when dry and chroma of 1 to 3 when moist and dry.

The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6 when moist and 5 to 8 when dry, and chroma of 1 to 3 when moist and dry. It is silty clay loam or silty clay.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 when moist and 7 or 8 when dry, and chroma of 1 or 2 when moist and dry. It is dominantly silty clay loam, silty clay, or clay. In some pedons, however, it has thin strata of silt loam or sandy loam.

The Bellingham soils in this survey area are taxadjuncts to the series because they have a mollic epipedon. This difference, however, does not significantly affect the use and management of the soils.

### **Birchbay Series**

The Birchbay series consists of very deep, moderately well drained soils formed in an admixture of loess and volcanic ash over glaciofluvial deposits and glaciomarine drift. These soils are on wave-reworked glaciomarine drift plains. Slopes are 0 to 15 percent. The average annual precipitation is 30 to 40 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Birchbay silt loam, 0 to 3 percent slopes, 5 miles west of Ferndale, 2,400 feet south and 1,600 feet east of the northwest corner of sec. 16, T. 39 N., R. 1 E.

Ap-0 to 8 inches; dark brown (10YR 3/3) silt loam, dark yellowish brown (10YR 4/4) dry; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine roots; many very fine irregular pores; about 2 percent pebbles; NaF pH 9.8; slightly acid; abrupt smooth boundary.

Bs1-8 to 12 inches; dark brown (7.5YR 4/4) silt loam, strong brown (7.5YR 5/6) 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; about 10

percent pebbles; NaF pH 10.5; moderately acid; clear smooth boundary.

Bs2-12 to 24 inches; dark yellowish brown (10YR 4/4) 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 fine roots; many very fine irregular pores; about 20 percent pebbles; NaF pH 11.0; moderately acid; clear smooth boundary.

2C1-24 to 42 inches; dark yellowish brown (10YR 4/4) very gravelly sand, brownish yellow (10YR 6/6) dry; massive; slightly hard, very friable, nonsticky and nonplastic; very few fine roots; many fine irregular pores; about 35 percent pebbles and 5 percent cobbles; NaF pH 11.0; moderately acid; clear wavy boundary.

3C2-42 to 60 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; many large prominent strong brown (7.5YR 5/6) mottles, reddish yellow (7.5YR 6/6) dry; massive; very hard, firm, slightly sticky and slightly plastic; few fine irregular pores; about 10 percent pebbles; moderately acid.

The thickness of the part of the profile influenced by volcanic ash and the depth to the 2C horizon are 14 to 32 inches. Depth to the 3C horizon is 40 to 60 inches.

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 2 to 4 when moist and 3 or 4 when dry.

The Bs 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 and dry. It is silt loam, loam, gravelly silt loam, or gravelly loam.

The 2C horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist and 2 to 6 when dry. It is very gravelly loamy sand or very gravelly sand.

The 3C horizon has hue of 10YR to 5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist and dry. It is dominantly loam, gravelly loam, clay loam, gravelly clay loam, or silty clay loam. In some pedons, however, it has thin strata of sandy loam.

### **Blainegate Series**

The Blainegate series consists of very deep, poorly drained soils formed in marine deposits. These soils are on marine terraces. Slopes are 0 to 1 percent. The average annual precipitation is 30 to 40 inches, and the mean annual air temperature is about 50 degrees F.

These soils are very fine, mixed, mesic Typic Argiaquolls.

Typical pedon of Blainegate silty clay, 0 to 1 percent slopes, 1 mile east of Blaine, 2,600 feet south and 1,800 feet east of the northwest corner of sec. 5, T. 40 N., R. 1 E.

- Ap-0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; few fine prominent yellowish brown (10YR 5/8) mottles, brownish yellow (10YR 6/8) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and plastic; many very fine and common fine roots; many very fine irregular pores; moderately acid; abrupt smooth boundary.
- Btg-9 to 27 inches; dark gray (5Y 4/1) clay, light gray (5Y 7/1) dry; many fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, sticky and plastic; many very fine and common fine roots; many very fine irregular and common very fine tubular pores; few patchy clay films on faces of peds; slightly acid; clear smooth boundary.
- C1-27 to 45 inches; gray (5Y 6/1) clay, white (5Y 8/1) dry; many fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; hard, firm, sticky and plastic; common very fine roots; few very fine irregular and common very fine tubular pores; neutral; clear smooth boundary.
- C2-45 to 60 inches; light brownish gray (2.5Y 6/2) clay, white (2.5Y 8/2) dry; many coarse prominent light olive brown (2.5Y 5/6) mottles, olive yellow (2.5Y 6/6) dry; massive; hard, firm, sticky and plastic; common very fine roots; few very fine irregular and common very fine tubular pores; neutral.

The particle-size control section has 60 to 75 percent clay by weighted average. The thickness of the solum is 10 to 30 inches.

The Ap horizon has value of 2 or 3 when moist and 4 or 5 when dry and chroma of 1 to 3 when moist and dry. The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6 when moist and 5 to 8 when dry, and chroma of 1 or 2 when moist and dry. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 when moist and 7 or 8 when dry, and chroma of 1 or 2 when moist and dry. In some pedons it has thin strata of silt loam, silty clay loam, or sandy loam.

### **Blethen Series**

The Blethen series consists of very deep, well drained soils formed in glacial till, colluvium, and slope alluvium with an admixture of volcanic ash and loess. These soils are on side slopes and toe slopes of

foothills and landslides. Slopes are 5 to 60 percent. The average annual precipitation is 50 to 70 inches, and the mean annual air temperature is about 47 degrees F.

These soils are loamy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Blethen gravelly loam, 15 to 30 percent slopes, 10 miles east of Lynden, 1,300 feet north and 500 feet east of the southwest corner of sec. 13, T. 40 N., R. 4 E.

- Oi-0.75 to 0.25 inch; leaves, needles, twigs, and cones.
- Oa-0.25 inch to 0; decomposed needles, leaves, and twigs; common very fine and fine roots.
- A1-0 to 2 inches; dark brown (7.5YR 3/3) gravelly loam, brown (7.5YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; many very fine and fine and common medium roots; many very fine irregular pores; about 15 percent pebbles and 5 percent cobbles; NaF pH 9.8; slightly acid; clear smooth boundary.
- A2-2 to 6 inches; dark brown (7.5YR 3/3) gravelly loam, strong brown (7.5YR 4/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common very fine, fine, and medium and few coarse roots; common very fine irregular pores; about 15 percent pebbles and 5 percent cobbles; NaF pH 10.1; moderately acid; clear smooth boundary.
- Bs1-6 to 18 inches; dark brown (7.5YR 4/4) very cobbly loam, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common very fine, fine, medium, and coarse roots; common very fine irregular pores; about 25 percent pebbles and 15 percent cobbles; NaF pH 10.1; moderately acid; clear wavy boundary.
- Bs2-18 to 28 inches; dark yellowish brown (10YR 4/4) very cobbly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine and medium and few coarse roots; common very fine irregular pores; about 25 percent pebbles and 15 percent cobbles; NaF pH 10.5; moderately acid; gradual smooth boundary.
- Bs3-28 to 41 inches; dark yellowish brown (10YR 4/4) very cobbly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; weakly smeary; few fine and medium roots; many very fine irregular pores; about 30 percent pebbles and 20 percent cobbles; NaF pH 10.1; moderately acid;

gradual smooth boundary.

C-41 to 60 inches; olive brown (2.5Y 4/4) very cobbly loam, light yellowish brown (10YR 6/4) dry; massive; hard, friable, nonsticky and nonplastic; weakly smeary; few fine roots; few very fine irregular pores; about 40 percent pebbles and 20 percent cobbles; NaF pH 10.6; slightly acid.

The thickness of the solum and of the part of the profile influenced by volcanic ash is 26 to 50 inches. The content of rock fragments in the control section ranges from 35 to 60 percent. It includes 30 to 50 percent pebbles and 5 to 20 percent cobbles.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry.

The Bs 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 and dry. It is very gravelly loam, very gravelly silt loam, very cobbly loam, or very cobbly silt loam.

The C horizon has hue of 10YR or 2.5YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 3 or 4 when moist and dry. It is very gravelly loam, very gravelly sandy loam, very cobbly loam, or very cobbly sandy loam.

### **Briscot Series**

The Briscot series consists of very deep, poorly drained soils that have been artificially drained. They formed in alluvium on flood plains. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy, mixed, nonacid, mesic Aeric Fluvaquents.

Typical pedon of Briscot silt loam, drained, 0 to 2 percent slopes, 3 miles south of Sumas, 400 feet south and 2,400 feet east of the northwest corner of sec. 15, T. 40 N., R. 4 E.

Ap-0 to 9 inches; dark grayish brown (2.5Y 4/2) silt loam, light gray (2.5Y 5/2) dry; moderate medium subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium roots; many very fine irregular and many very fine tubular pores; few fine pebbles; moderately acid; abrupt smooth boundary.

C1-9 to 14 inches; dark grayish brown (2.5Y 4/2) silt loam, light gray (2.5Y 7/2) dry; common fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; moderate coarse

subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium roots; many very fine irregular and many very fine tubular pores; moderately acid; abrupt wavy boundary.

C2-14 to 22 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam, light gray (2.5Y 7/2) dry; many large prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine and common fine roots; many very fine irregular and many very fine tubular pores; moderately acid; abrupt smooth boundary.

C3-22 to 34 inches; gray (5Y 6/1) fine sand, light gray (5Y 7/1) dry; many large prominent olive brown (2.5Y 4/4) mottles, light yellowish brown (2.5Y 6/4) dry; massive; soft, friable, nonsticky and nonplastic; common very fine and few medium roots; many very fine irregular pores; slightly acid; abrupt smooth boundary.

C4-34 to 41 inches; gray (5Y 5/1) fine sandy loam, light gray (5Y 7/1) dry; many large prominent olive brown (2.5Y 4/4) mottles, light yellowish brown (2.5Y 6/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; slightly acid; abrupt smooth boundary.

C5-41 to 60 inches; gray (5Y 5/1) and light brownish gray (2.5Y 6/2) silt loam, light gray (5Y 7/1 and 2.5Y 7/2) dry; many medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine irregular and common very fine tubular pores; slightly acid.

The control section is, by weighted average, 5 to 12 percent clay and 15 to 60 percent sand coarser than very fine sand. These soils have an irregular distribution of organic matter with increasing depth.

The A horizon has hue of 10YR or 2.5Y and value of 3 or 4 when moist and 6 or 7 when dry. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 7 when dry, and chroma of 1 or 2 when moist and dry. It has mottles with hue of 10YR or 2.5Y, value of 4 or 5 when moist, and chroma of 4 to 6 when moist and dry. It is stratified silt loam, very fine sandy loam, fine sandy loam, fine sand, or sand.

### **Chuckanut Series**

The Chuckanut series consists of deep and very deep, well drained soils formed in a mixture of volcanic ash and colluvium derived from glacial drift and

sandstone. These soils are on foothill side slopes, back slopes, toe slopes, and landslides. Slopes are 3 to 60 percent. The average annual precipitation is 35 to 60 inches, and the mean annual air temperature is about 49 degrees F.

These soils are coarse-loamy, mixed, mesic Typic Haplorthods.

Typical pedon of Chuckanut loam, 3 to 8 percent slopes, 3 miles southwest of Van Zandt, 1,000 feet south and 900 feet east of the northwest corner of sec. 19, T. 38 N., R. 4 E.

Ap-0 to 10 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots; many very fine irregular pores; few soft pebbles; NaF pH 11.0; moderately acid; clear smooth boundary.

Bw1-10 to 12 inches; olive brown (2.5Y 4/4) sandy loam, pale yellow (2.5Y 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine roots; few soft pebbles; NaF pH 11.0; moderately acid; clear smooth boundary.

Bw2-12 to 24 inches; dark brown (10YR 3/3) gravelly loam, pale brown (10YR 6/3) dry; weak fine subangular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine roots; many very fine irregular pores; about 15 percent hard pebbles and 5 percent soft pebbles; NaF pH 10.2; moderately acid; clear smooth boundary.

C-24 to 60 inches; olive brown (2.5Y 4/4) gravelly sandy loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine roots; many very fine irregular pores; about 20 percent hard pebbles and 60 percent soft pebbles; NaF pH 10.2; slightly acid.

The depth to sandstone is 40 to more than 60 inches. By weighted average, the content of rock fragments in the control section is 0 to 15 percent hard pebbles, 35 to 60 percent soft pebbles, and 0 to 5 percent hard cobbles.

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 2 or 3 when moist and 2 to 4 when dry.

The Bw horizon has hue of 7.5YR to 2.5Y, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist and dry. It is gravelly loam, gravelly sandy loam, or gravelly fine sandy loam.

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 and dry. It is gravelly loam or gravelly sandy loam.

### Clendenen Series

The Clendenen series consists of shallow, moderately well drained soils formed in a mixture of volcanic ash, loess, and colluvium over glacial till. These soils are on mountain back slopes and shoulder slopes. Slopes are 5 to 30 percent. The average annual precipitation is 80 to 100 inches, and the mean annual air temperature is about 41 degrees F.

These soils are loamy-skeletal, mixed, shallow Humic Cryorthods.

Typical pedon of Clendenen gravelly silt loam, 5 to 30 percent slopes, 800 feet north and 800 feet west of the southeast corner of sec. 33, T. 38 N., R. 6 E.

Oi-7 to 3 inches; undecomposed needles, leaves, and twigs.

Oa-3 inches to 0; decomposed forest litter; many fine, medium, and coarse roots.

E-0 to 2 inches; reddish gray (5YR 5/2) gravelly silt loam, pinkish gray (5YR 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; about 20 percent pebbles; many very fine roots; common fine irregular pores; very strongly acid; abrupt smooth boundary.

Bhs-2 to 5 inches; strong brown (7.5YR 4/6) gravelly silt loam, strong brown (7.5YR 5/6) dry; dark brown (7.5YR 3/2) organic stains, dark brown (7.5YR 4/4) dry; moderate medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; weakly smeary; common fine and medium roots; common very fine irregular pores; about 15 percent pebbles; strongly acid; clear smooth boundary.

Bs-5 to 16 inches; strong brown (7.5YR 5/6) very gravelly silt loam, reddish yellow (7.5YR 6/6) dry; moderate fine and medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; weakly smeary; about 40 percent pebbles; few fine roots; many very fine irregular pores; moderately acid; abrupt smooth boundary.

2Cd-16 to 60 inches; pale brown (10YR 6/3), dense glacial till that breaks to very gravelly loam, very pale brown (10YR 7/3) dry; yellowish red (5YR 4/6) organic stains, yellowish red (5YR 5/6) dry; massive; hard, firm, slightly sticky and slightly plastic; about 50 percent pebbles; moderately acid.

The depth to dense, compact glacial till is 14 to 20 inches. The content of rock fragments in the control section ranges from 40 to 65 percent.

The E horizon has hue of 5YR or 7.5YR and value of

4 or 5 when moist and 6 or 7 when dry.

The Bh<sub>s</sub> and Bs horizons have hue of 5YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist and dry. The fine-earth fraction is loam or silt loam.

The 2Cd horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist and dry. It is dense glacial till that breaks to very gravelly loam or very gravelly sandy loam.

### Clipper Series

The Clipper series consists of very deep, somewhat poorly drained soils formed in an admixture of loess and volcanic ash over glacial outwash. These soils are in depressions on outwash terraces and outwash plains. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy, mixed, mesic Aquic Haplothods.

Typical pedon of Clipper silt loam, drained, 0 to 2 percent slopes, 4 miles northeast of Lynden, 500 feet north and 2,400 feet east of the southwest corner of sec. 34, T. 41 N., R. 3 E.

Ap-0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many very fine roots; many very fine irregular and few fine tubular pores; about 5 percent pebbles; NaF pH 9.4; slightly acid; abrupt smooth boundary.

E1-9 to 18 inches; grayish brown (2.5Y 5/2) and gray (10YR 6/1) silt loam, light gray (2.5Y 7/2) and white (10YR 8/1) dry; many medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular and few very fine tubular pores; few pebbles; strongly acid; abrupt smooth boundary.

2E2-18 to 22 inches; grayish brown (2.5Y 5/2) and gray (10YR 5/1) gravelly sandy loam, light gray (2.5Y 7/2 and 10YR 7/1) dry; many medium prominent strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine irregular pores; about 30 percent pebbles; moderately acid; clear smooth boundary.

2Bs-22 to 30 inches; yellowish brown (10YR 5/8) very gravelly sandy loam, brownish yellow (10YR 6/8)

dry; many medium prominent grayish brown (2.5Y 5/2) mottles, light gray (2.5Y 7/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; very few very fine roots; many very fine irregular pores; about 30 percent pebbles; moderately acid; clear smooth boundary.

3C1-30 to 37 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) very gravelly loamy sand, light gray (2.5Y 7/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine irregular pores; about 50 percent pebbles and 5 percent cobbles; moderately acid; clear smooth boundary.

3C2-37 to 60 inches; dark grayish brown (2.5Y 4/2) very gravelly loamy sand, light brownish gray (2.5Y 6/2) dry; many fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; soft, friable, nonsticky and nonplastic; many very fine irregular pores; about 50 percent pebbles and 5 percent cobbles; moderately acid.

The thickness of the solum is 14 to 30 inches. By weighted average, the solum has 10 to 18 percent clay and the particle-size control section ranges from 15 to 35 percent rock fragments. The content of rock fragments increases with increasing depth. It ranges from 10 to 25 percent in the solum and from 25 to 60 percent in the substratum.

The A horizon has chroma of 2 or 3 when moist and dry. The E horizon has hue of 10YR to 5Y, value of 5 or 6 when moist and 7 or 8 when dry, and chroma of 1 or 2 when moist and dry. It is silt loam, loam, gravelly loam, or gravelly silt loam. The 2E horizon has hue of 10YR to 5Y, value of 5 or 6 when moist and 7 or 8 when dry, and chroma of 1 or 2 when moist and dry. It is mottled. It is gravelly sandy loam or gravelly loam.

The 2Bs 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 to 8 when moist and dry. It is gravelly loam, gravelly sandy loam, very gravelly loam, or very gravelly sandy loam.

The 3C 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 dry. It is massive or single grain and is loose, soft, or slightly hard. It is very gravelly loamy sand or very gravelly sand.

### Comar Series

The Comar series consists of deep, moderately well drained soils formed in a mixture of volcanic ash,

colluvium, and slope alluvium derived from siltstone and glacial till. These soils are on foothill back slopes and toe slopes. Slopes are 5 to 60 percent. The average annual precipitation is 50 to 65 inches, and the mean annual temperature is about 47 degrees F.

These soils are fine-loamy, mixed, mesic Typic Haplothods.

Typical pedon of Comar silt loam, 30 to 60 percent slopes, 1.5 miles northeast of Deming, 2,200 feet due south of the northwest corner of sec. 29, T. 39 N., R. 5 E.

Oi-5 to 4 inches; undecomposed needles, leaves, and twigs.

Oa-4 inches to 0; decomposed forest litter; many very fine, fine, medium, and coarse roots.

A-0 to 5 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many very fine, fine, medium, and coarse roots; many fine irregular pores; about 30 percent weathered pebbles and 10 percent unweathered pebbles; NaF pH 10.0; moderately acid; clear smooth boundary.

Bs-5 to 16 inches; brown (10YR 4/3) silt loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine and common medium and coarse roots; many fine irregular pores; about 20 percent weathered pebbles and 5 percent unweathered pebbles; NaF pH 10.5; moderately acid; clear smooth boundary.

2C1-16 to 39 inches; light olive brown (2.5Y 5/4) silt loam, very pale brown (10YR 7/3) dry; massive; very hard, firm, sticky and plastic; many very fine and fine and few medium roots; many fine and medium irregular pores; about 75 percent weathered pebbles; NaF pH 9.4; strongly acid; clear smooth boundary.

2C2-39 to 44 inches; light olive brown (2.5Y 5/4) silt loam; pale yellow (2.5YR 7/4) dry; massive; very hard, firm, sticky and plastic; common very fine and fine and few medium roots; many fine and medium irregular pores; about 60 percent weathered pebbles; strongly acid; abrupt wavy boundary.

2Cr-44 inches; siltstone.

The depth to siltstone is more than 40 inches. The lower part of the control section has 20 to 30 percent clay. The thickness of the part of the profile influenced by volcanic ash is 14 to 24 inches. The content of rock fragments in the particle-size control section ranges

from 0 to 25 percent unweathered pebbles and 15 to 80 percent weathered pebbles.

The A horizon has chroma of 3 or 4 when moist and dry. The Bs horizon has value of 5 or 6 when dry and chroma of 3 or 4 when moist and dry. It is loam or silt loam. The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 5 to 8 when dry, and chroma of 3 or 4 when moist and dry. It is silt loam, silty clay loam, or gravelly silt loam.

### **Crinker Series**

The Crinker series consists of moderately deep, well drained soils formed in an admixture of volcanic ash, colluvium, slope alluvium, and glacial till derived dominantly from phyllite. These soils are on high mountain back slopes and shoulder slopes. Slopes are 30 to 60 percent. The average annual precipitation is 80 to 95 inches, and the mean annual air temperature is about 42 degrees F.

These soils are loamy-skeletal, mixed Typic Cryorthods.

Typical pedon of Crinker very channery silt loam, 30 to 60 percent slopes, 5.5 miles east of Acme, 1,000 feet north and 1,500 feet west of the southeast corner of sec. 7, T. 37 N., R. 6 E.

Oa-6 inches to 0; decomposed needles, leaves, and twigs; many very fine, fine, medium, and coarse roots.

E1-0 to 3 inches; dark brown (7.5YR 4/2) very channery loam, pinkish gray (7.5YR 7/2) and light gray (10YR 7/1) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine irregular pores; about 35 percent channers; extremely acid; clear smooth boundary.

E2-3 to 6 inches; reddish brown (5YR 5/3) very channery silt loam, pinkish gray (5YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine irregular pores; about 40 percent channers; extremely acid; abrupt smooth boundary.

Bhs-6 to 9 inches; strong brown (7.5YR 5/6) very channery silt loam, brownish yellow (10YR 6/6) dry; dark reddish brown (5YR 2/2) organic stains, very dark gray (5YR 3/1) dry; massive; hard; very firm, nonsticky and nonplastic; weakly smeary; many very fine irregular pores; about 50 percent channers; NaF pH 11.0; very strongly acid; clear smooth boundary.

Bs1-9 to 18 inches; yellowish brown (10YR 5/6) very channery silt loam, brownish yellow (10YR 6/6) dry; dark reddish brown (5YR 2/2) organic stains, dark

reddish brown (5YR 3/2) dry; massive; very hard, very firm, nonsticky and nonplastic; weakly smeary; common very fine irregular pores; about 55 percent channers; NaF pH 12.0; strongly acid; clear smooth boundary.

Bs2-18 to 24 inches; yellowish brown (10YR 5/4) very channery silt loam, light yellowish brown (10YR 6/4) dry; dark reddish brown (5YR 2/2) organic stains, dark reddish brown (5YR 3/2) dry; weak fine subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; weakly smeary; many very fine irregular pores; about 60 percent channers; NaF pH 12.0; very strongly acid; clear smooth boundary.

R-24 inches; phyllite.

The depth to phyllite is 20 to 40 inches. The content of hard phyllite rock fragments in the particle-size control section ranges from 40 to 60 percent.

The E 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 1 to 3 when moist and dry.

The Bhs 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 4 to 6 when moist and dry. It is very channery loam or very channery silt loam.

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 and dry. It is very channery loam or very channery silt loam.

Some pedons have a C horizon. This 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 and dry. It is very channery loam or extremely channery loam.

#### **Cupples Series**

The Cupples series consists of moderately deep, moderately well drained soils formed in a mixture of volcanic ash and loess over glacial till. These soils are on mountain back slopes and plateaus. Slopes are 5 to 60 percent. The average annual precipitation is 60 to 80 inches, and the mean annual air temperature is about 44 degrees F.

These soils are loamy-skeletal, mixed, frigid Typic Haplorthods.

Typical pedon of Cupples gravelly loam, 5 to 30 percent slopes, 5 miles northeast of Deming, 2,200 feet north and 2,400 feet west of the southeast corner of sec. 23, T. 39 N., R. 5 E.

Oi-7 to 5 inches; undecomposed needles and twigs. Oa-5 inches to 0; decomposed forest litter; many very fine, fine, medium, and coarse roots.

E-0 to 2 inches; dark brown (7.5YR 4/2) gravelly fine sandy loam, pinkish gray (7.5YR 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine and fine, common medium, and few coarse roots; common very fine irregular pores; about 15 percent pebbles and 5 percent cobbles; very strongly acid; abrupt smooth boundary.

Bhs-2 to 5 inches; dark brown (7.5YR 3/4) and dark yellowish brown (10YR 3/4) gravelly silt loam, strong brown (7.5YR 5/6) and light yellowish brown (10YR 6/4) dry; dark reddish brown (5YR 3/2) organic stains, dark reddish brown (5YR 3/3) dry; moderate medium and coarse subangular blocky structure; hard, very firm, nonsticky and nonplastic; weakly smeary; common fine and medium roots; common very fine irregular pores; about 20 percent hard pebbles, 20 percent soft pebbles, and 5 percent cobbles; strongly acid; abrupt smooth boundary.

Bs-5 to 10 inches; dark brown (7.5YR 3/4) gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and common medium and coarse roots; many very fine irregular pores; about 10 percent hard pebbles, 30 percent soft pebbles, and 5 percent cobbles; moderately acid; clear wavy boundary.

BC1-10 to 21 inches; olive brown (2.5Y 4/4) very gravelly loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and few medium and coarse roots; many very fine irregular pores; about 30 percent hard pebbles, 25 percent soft pebbles, and 5 percent cobbles; slightly acid; abrupt wavy boundary.

BC2-21 to 30 inches; dark yellowish brown (10YR 4/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine and medium roots; many very fine irregular pores; about 40 percent hard pebbles; slightly acid; abrupt smooth boundary.

2Cd-30 to 60 inches; light olive brown (2.5Y 5/4), dense glacial till that breaks to very gravelly sandy loam, pale yellow (2.5Y 7/4) dry; hard, friable, nonsticky and nonplastic; about 45 percent hard pebbles, 15 percent soft pebbles, and 5 percent cobbles; slightly acid.

The depth to dense, compact glacial till is 20 to 40 inches. The content of rock fragments in the particle-

size control section ranges from 35 to 45 percent hard pebbles, 5 to 25 percent soft pebbles, and 0 to 5 percent cobbles.

The E horizon has hue of 7.5YR or 10YR and value of 3 or 4 when moist and 6 or 7 when dry.

The Bhs and Bs horizons have 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 and dry. They are gravelly loam or gravelly silt loam.

The BC horizon has hue of 10YR or 2.5Y and value of 4 or 5 when moist and 5 or 6 when dry.

The 2Cd horizon has value of 4 or 5 when moist and 6 or 7 when dry. It is dense glacial till that breaks to very gravelly loam or very gravelly sandy loam.

### Dekapen Series

The Dekapen series consists of moderately deep, moderately well drained soils formed in a mixture of volcanic ash and loess over glacial till derived from sandstone. These soils are on mountain plateaus and back slopes. Slopes are 8 to 25 percent. The average annual precipitation is 60 to 75 inches, and the mean annual air temperature is about 44 degrees F.

These soils are coarse-loamy, mixed, frigid Typic Haplorthods.

Typical pedon of Dekapen loam, 8 to 25 percent slopes, 2 miles southeast of Van Zandt, 1,700 feet north and 2,400 feet west of the southeast corner of sec. 15, T. 38 N., R. 5 E.

Oi-1 to 0.25 inch; undecomposed needles, leaves, and twigs.

Oa-0.25 inch to 0; decomposed forest litter; many medium roots.

E-0 to 2 inches; dark brown (7.5YR 3/2) gravelly silt loam, pinkish gray (7.5YR 6/2) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many fine and medium roots; many fine irregular pores; about 10 percent soft pebbles and 15 percent hard pebbles; strongly acid; abrupt wavy boundary.

Bhs-2 to 8 inches; dark brown (7.5YR 3/4) loam, light brown (10YR 6/4) dry; dark reddish brown (5YR 3/2) organic stains, dark brown (7.5YR 4/4) dry; weak fine and medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; weakly smeary; many very fine and medium roots; common fine irregular pores; about 40 percent soft pebbles, 10 percent soft cobbles, and 5 percent hard pebbles; strongly acid; clear wavy boundary.

Bs1-8 to 18 inches; yellowish brown (10YR 5/4) loam, very pale brown (10YR 7/4) dry; weak medium

subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; weakly smeary; many very fine and fine and few medium roots; many fine irregular pores; about 25 percent soft pebbles and 10 percent hard pebbles; strongly acid; clear wavy boundary.

Bs2-18 to 24 inches; dark yellowish brown (10YR 3/4) loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; weakly smeary; many very fine and fine roots; many medium irregular and common medium tubular pores; about 30 percent soft pebbles and 5 percent hard pebbles; strongly acid; clear smooth boundary.

2C-24 to 31 inches; olive brown (2.5Y 4/4) loam, pale yellow (2.5Y 7/4) dry; common fine distinct dark brown (7.5YR 4/4) mottles, brown (7.5YR 5/4) dry; massive; soft, friable, nonsticky and nonplastic; common very fine and many fine and medium irregular and common fine tubular pores; about 30 percent soft pebbles and 5 percent hard pebbles; strongly acid; abrupt smooth boundary.

2Cd-31 to 60 inches; light olive brown (2.5Y 5/4), dense glacial till that breaks to loam, pale yellow (2.5Y 7/4) dry; common fine prominent strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry; massive; very hard, very firm, nonsticky and nonplastic; few very fine irregular pores; about 15 percent soft pebbles and 5 percent hard pebbles; strongly acid.

The thickness of the solum and of the part of the profile influenced by volcanic ash is 24 to 32 inches. The depth to dense, compact glacial till is 24 to 40 inches. By weighted average, the content of rock fragments in the particle-size control section is 25 to 40 percent soft pebbles, 0 to 15 percent soft cobbles, and 5 to 15 percent hard pebbles.

The E horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 2 or 3 when moist and dry.

The Bhs and Bs horizons have hue of 7.5YR or 10YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist and dry. They are loam or sandy loam.

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 dry. It is loam or sandy loam.

The 2Cd horizon is dense glacial till that breaks to loam or sandy loam. It 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 dry.

## Deming Series

The Deming series consists of very deep, well drained soils formed in a mixture of volcanic ash, slope alluvium, and colluvium over unconsolidated glacial till. The slope alluvium, colluvium, and glacial till are derived from sandstone, conglomerate, metasedimentary rocks, and volcanic rocks. These soils are on mountain back slopes. Slopes are 5 to 60 percent. The average annual precipitation is 80 to 95 inches, and the mean annual air temperature is about 40 degrees F.

These soils are loamy-skeletal, mixed Humic Cryorthods.

Typical pedon of Deming gravelly silt loam, 30 to 60 percent slopes, 6 miles northeast of Glacier, 1,900 feet north and 800 feet west of the southeast corner of sec. 10, T. 40 N., R. 6 E.

Oi-4 inches to 1 inch; undecomposed needles, twigs, leaves, wood fragments, and moss.

Oa-1 inch to 0; decomposed needles, twigs, and leaves; many very fine, fine, medium, and coarse roots.

E-0 to 3 inches; dark brown (7.5YR 4/2) gravelly silt loam, pinkish gray (7.5YR 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine and fine and common medium and coarse roots; many very fine irregular pores; about 20 percent pebbles and 5 percent cobbles; extremely acid; abrupt smooth boundary.

Bhs-3 to 8 inches; dark reddish brown (5YR 3/4) gravelly silt loam, yellowish red (5YR 4/6) dry; dark reddish brown (5YR 2/2) organic stains on faces of peds, dark brown (7.5YR 3/3) dry; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many fine and common very fine, medium, and coarse roots; common very fine irregular pores; about 20 percent pebbles and 5 percent cobbles; NaF pH less than 9.0; very strongly acid; abrupt smooth boundary.

Bs1-8 to 15 inches; strong brown (7.5YR 4/6) very gravelly loam, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many fine and medium and common very fine and coarse roots; common very fine irregular pores; about 35 percent pebbles and 5 percent cobbles; NaF pH 11.5; strongly acid; clear wavy boundary.

Bs2-15 to 24 inches; dark brown (7.5YR 4/4) very gravelly sandy loam, yellowish brown (10YR 5/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few

medium roots; common very fine irregular pores; about 45 percent pebbles and 10 percent cobbles; NaF pH 11.5; very strongly acid; clear wavy boundary.

BC-24 to 37 inches; dark yellowish brown (10YR 3/4) extremely gravelly sandy loam, dark yellowish brown (10YR 4/4) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few medium roots; many very fine irregular pores; about 50 percent pebbles, 10 percent cobbles, and 5 percent stones; NaF pH 11.0; very strongly acid; clear smooth boundary.

2C-37 to 60 inches; dark yellowish brown (10YR 4/4) extremely gravelly loamy sand, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine roots; many fine irregular pores; about 60 percent pebbles and 5 percent cobbles; NaF pH 10.5; strongly acid.

The thickness of the part of the profile influenced by volcanic ash is more than 40 inches. The thickness of the solum is 24 to 40 inches. The content of rock fragments in the control section ranges from 45 to 60 percent.

The E horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 or 3 when moist and dry.

The Bhs horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist and 3 to 5 when dry, and chroma of 4 to 6 when moist and dry.

The Bs and BC horizons have hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 to 6 when moist and dry. They are very gravelly loam, very gravelly sandy loam, or extremely gravelly sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 6 when moist and dry. It is very gravelly loam, very gravelly sandy loam, or extremely gravelly loamy sand.

## Diobsud Series

The Diobsud series consists of moderately deep, moderately well drained soils formed in a mixture of volcanic ash and colluvium over glacial till derived from phyllite. These soils are on mountain back slopes and ridges. Slopes are 30 to 60 percent. The average annual precipitation is 85 to 95 inches, and the mean annual air temperature is about 42 degrees F.

These soils are coarse-loamy, mixed Humic Cryorthods.

Typical pedon of Diobsud gravelly silt loam, 30 to 60 percent slopes, 9.5 miles east of Wickersham, 2,600

feet south and 100 feet east of the northwest corner of sec. 35, T. 37 N., R. 6 E.

Oa-7 to 3 inches; undecomposed needles, leaves, and twigs.

Oi-3 inches to 0; decomposed needles, leaves, and twigs; many very fine and fine and few medium roots.

E-0 to 4 inches; dark brown (7.5YR 3/2) gravelly silt loam, pinkish gray (7.5YR 6/2) dry; massive; soft, friable, nonsticky and nonplastic; common very fine, fine, and medium roots; many very fine irregular pores; about 30 percent pebbles; extremely acid; abrupt smooth boundary.

Bhs-4 to 11 inches; dark brown (7.5YR 3/4) gravelly silt loam, brown (7.5YR 5/4) dry; reddish brown (5YR 5/4) organic stains, light reddish brown (5YR 6/4) dry; moderate coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few medium roots; many very fine irregular pores; about 30 percent pebbles; NaF pH 10.0; very strongly acid; abrupt irregular boundary.

Bs-11 to 16 inches; strong brown (7.5YR 4/6) gravelly silt loam, reddish yellow (7.5YR 6/6) dry; moderate coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine, fine, and medium roots; many very fine irregular pores; about 25 percent pebbles; NaF pH 12.0; strongly acid; clear irregular boundary.

BC-16 to 20 inches; brown (10YR 5/3) gravelly silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine and fine roots; many very fine irregular pores; about 30 percent pebbles; NaF pH 12.0; strongly acid; clear smooth boundary.

C-20 to 37 inches; olive gray (5Y 5/2) gravelly loam, light olive gray (5Y 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; very few very fine roots; common very fine irregular pores; about 30 percent pebbles; NaF pH 12.0; strongly acid; abrupt smooth boundary.

2Cd-37 to 60 inches; olive gray (5Y 4/2), dense glacial till that breaks to very gravelly loam, light olive gray (5Y 6/2) dry; massive; hard, firm, nonsticky and nonplastic; about 45 percent pebbles; NaF pH 12.0; strongly acid.

The depth to dense, compact glacial till is 20 to 40 inches. The particle-size control section ranges from 20 to 35 percent hard phyllite fragments.

The E horizon has hue of 7.5YR or 10YR, value of 3

to 5 when moist and 6 to 8 when dry, and chroma of 1 or 2 when moist and dry.

The Bhs and Bs horizons have 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 and dry. They are gravelly loam or gravelly silt loam.

The BC horizon has hue of 10YR or 2.5Y, value of 4 or 5 when moist and 6 to 8 when dry, and chroma of 2 or 3 when moist and dry. It is gravelly loam or gravelly silt loam.

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 and dry. It is gravelly loam or gravelly clay loam.

The 2Cd horizon is dense glacial till that breaks to gravelly loam or very gravelly loam. It 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 and dry.

### Edfro Series

The Edfro series consists of shallow, moderately well drained soils formed in a mixture of volcanic ash, loess, and colluvium over glacial till derived from dunite. These soils are on high mountain shoulder slopes and back slopes. Slopes are 8 to 60 percent. The average annual precipitation is 85 to 105 inches, and the mean annual temperature is about 41 degrees F.

These soils are loamy-skeletal, serpentinitic, shallow Typic Cryorthods.

Typical pedon of Edfro very gravelly silt loam, 30 to 60 percent slopes, 7 miles east of Acme, 1,700 feet south and 1,700 feet east of the northwest corner of sec. 4, T. 37 N., R. 6 E.

Oi-4 to 3.5 inches; needles, leaves, and twigs.

Oa-3.5 inches to 0; decomposed needles, twigs, and bark; many very fine and common fine roots.

E-0 to 3 inches; brown (7.5YR 5/2) very gravelly silt loam, pinkish gray (7.5YR 7/2) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; about 30 percent pebbles and 5 percent cobbles; NaF pH 10.0; extremely acid; abrupt wavy boundary.

Bhs1-3 to 7 inches; strong brown (7.5YR 4/6) very gravelly silt loam, strong brown (7.5YR 5/8) dry; dark reddish brown (2.5YR 3/4) organic stains on faces of peds, yellowish red (5YR 4/6) dry; moderate medium and coarse subangular blocky structure; hard, very firm, nonsticky and nonplastic; weakly smeary; common very fine roots; many very fine irregular pores; about 45 percent pebbles and

10 percent cobbles; NaF pH 11.5; very strongly acid; clear wavy boundary.

Bhs2-7 to 17 inches; yellowish red (5YR 4/6) extremely gravelly silt loam, yellowish red (5YR 5/6) dry; dark reddish brown (2.5YR 3/4) organic stains on faces of peds, reddish brown (5YR 4/4) dry; moderate medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; weakly smeary; few very fine roots; common very fine irregular pores; about 50 percent pebbles and 10 percent cobbles; NaF pH 12.0; very strongly acid; clear wavy boundary.

Bhs3-17 to 19 inches; dark brown (7.5YR 4/4) extremely gravelly loam, strong brown (7.5YR 4/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; very few very fine roots; many fine irregular pores; about 60 percent pebbles; NaF pH 12.0; very strongly acid; abrupt wavy boundary.

2Cd-19 to 60 inches; light yellowish brown (2.5Y 6/4), dense compact glacial till that breaks to very gravelly loam, light gray (2.5Y 7/2) dry; massive; extremely hard, very firm, nonsticky and nonplastic; weakly smeary; about 40 percent pebbles; NaF pH 10.5; very strongly acid.

The depth to dense, compact glacial till ranges from 14 to 20 inches. The content of rock fragments in the control section ranges from 40 to 60 percent, which includes 5 to 10 percent cobbles.

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 2 or 3 when moist and 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 4 to 6 when moist and 6 to 8 when dry. It is very gravelly loam or very gravelly silt loam.

The 2Cd horizon is dense, compact glacial till. It has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 4 to 7 when dry, and chroma of 2 to 4 when moist and 1 to 4 when dry. It is dense glacial till that breaks to very gravelly loam, very gravelly sandy loam, or very gravelly loamy sand.

### Edmonds Series

The Edmonds series consists of very deep, somewhat poorly drained soils formed in an admixture of loess and volcanic ash over glacial outwash. These soils are on outwash terraces and outwash plains. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy over sandy or sandy

skeletal, mixed, mesic, ortstein Typic Sideraquods.

Typical pedon of Edmonds loam, in an area of Edmonds-Woodlyn loams, drained, 0 to 2 percent slopes; 3 miles north of Ferndale, 1,200 feet south and 1,900 feet east of the northwest corner of sec. 8, T. 39 N., R. 2 E.

Ap1-0 to 6 inches; dark brown (7.5YR 3/2) loam, pinkish gray (7.5YR 6/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine irregular pores; NaF pH 9.9; moderately acid; clear smooth boundary.

Ap2-6 to 11 inches; dark brown (7.5YR 4/2) loam, pinkish gray (7.5YR 7/2) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine irregular pores; NaF pH 10.4; moderately acid; abrupt smooth boundary.

E-11 to 18 inches; dark grayish brown (10YR 4/2) loam, light gray (10YR 7/2) dry; moderate medium subangular blocky structure; hard, firm, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; NaF pH 11.0; moderately acid; abrupt smooth boundary.

2Bs-18 to 23 inches; dark brown (10YR 3/3) loamy sand, pale brown (10YR 6/3) dry; many coarse prominent dark yellowish brown (10YR 3/6) mottles, reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; NaF pH 11.1; moderately acid; abrupt smooth boundary.

2Bsm-23 to 37 inches; yellowish red (5YR 4/6 and 5/6) loamy sand, reddish yellow (5YR 6/6 and 7.5YR 6/6) dry; 75 percent ortstein concretions 2 to 6 inches in diameter; many coarse prominent dark brown (10YR 4/3) mottles, very pale brown (10YR 7/3) dry; massive; extremely hard ortstein and slightly hard matrix; extremely firm ortstein and friable matrix; nonsticky and nonplastic; few fine irregular pores in matrix; NaF pH 10.7; moderately acid; abrupt smooth boundary.

2C-37 to 60 inches; sand that is dominantly dark grayish brown (2.5Y 4/2) but is variegated; light brownish gray (2.5Y 6/2) dry; single grain; loose; many fine irregular pores; about 5 percent pebbles; NaF pH 9.9; slightly acid.

The thickness of the solum is 20 to 40 inches. The thickness of the loamy part of the solum is 14 to 20 inches. The particle-size control section is 0 to 5 percent pebbles by weighted average.

The Ap horizon has hue of 7.5YR or 10YR, value of

3 or 4 when moist and 6 or 7 when dry, and chroma of 1 to 3 when moist and dry. Reaction is strongly acid or moderately acid. Pedons in uncultivated areas have an A horizon. This horizon is 3 to 7 inches thick and is similar to the Ap horizon.

The E horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist and dry. It is loam or sandy loam.

The 213s horizon has hue of 7.5YR or 10YR in the matrix and 5YR or 7.5YR in the ortstein or mottles. It has value of 3 to 5 when moist and 5 to 7 when dry. It has chroma of 2 to 4 when moist and dry in the matrix and 4 to 6 in the ortstein or mottles. It is loamy sand or sand. It has a subhorizon that is 50 to 80 percent ortstein occurring as rounded or angular concretions, slaglike fragments, or irregularly shaped indurated accretions. This horizon is at least 5 inches thick.

The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 or 4 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist and dry. It is coarse sand or sand.

### Eliza Series

The Eliza series consists of very deep, very poorly drained soils formed in alluvium. These soils are on flood plains, deltas, and tidal flats. Slopes are 0 to 1 percent. The average annual precipitation is about 30 to 40 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy, mixed, acid, mesic Sulfic Fluvaquents.

Typical pedon of Eliza silt loam, drained, 0 to 1 percent slopes, 3 miles southwest of Ferndale, 1,200 feet north and 1,200 feet east of the southwest corner of sec. 6, T. 38 N., R. 2 E.

Ap-0 to 11 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) silt loam, light brownish gray (2.5Y 6/2) and light gray (10YR 7/2) dry; moderate medium granular structure; very hard, friable, slightly sticky and plastic; many very fine and fine roots; many very fine irregular pores; moderately acid when moist and strongly acid when dry; abrupt smooth boundary.

Cg1-11 to 15 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) and light gray (2.5Y 7/2) dry; common medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; very hard, friable, slightly sticky and plastic; many very fine and fine irregular pores; strongly acid when moist and very strongly acid when dry; abrupt smooth boundary.

Cg2-15 to 19 inches; gray (5Y 5/1) fine sandy loam,

light gray (5Y 6/1) dry; many coarse prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; many very fine irregular pores; very strongly acid when moist and dry; abrupt smooth boundary.

Cg3-19 to 24 inches; dark gray (N 4/0) fine sandy loam, gray (N 6/0) dry; many medium prominent dark yellowish brown (10YR 4/6) mottles, yellowish brown (10YR 5/6) dry; massive; soft, very friable, nonsticky and slightly plastic; common very fine and fine and few medium roots; many very fine irregular pores; very strongly acid when moist and dry; clear smooth boundary.

Cg4-24 to 34 inches; stratified dark gray (5Y 4/1) silt loam, gray (N 5/0) fine sandy loam, and strong brown (7.5YR 5/8) sand, gray (N 5/0), light gray (N 6/0), and strong brown (7.5YR 5/8) dry; massive in silt loam and fine sandy loam and single grain in sand; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and common fine irregular pores; very strongly acid when moist and extremely acid when dry; clear smooth boundary.

Cg5-34 to 44 inches; stratified dark grayish brown (2.5Y 4/2) silt loam, dark gray (5Y 4/1) fine sandy loam, and yellowish brown (10YR 5/6) sand, light brownish gray (2.5Y 6/2), light gray (N 7/0), and brownish yellow (10YR 6/6) dry; massive in silt loam and fine sandy loam and single grain in sand; soft, very friable, nonsticky and nonplastic; very few very fine roots; very strongly acid when moist and extremely acid when dry; abrupt smooth boundary.

Cg6-44 to 52 inches; stratified dark gray (5Y 4/1) silt loam and fine sandy loam and dark yellowish brown (10YR 4/6) sand, light gray (N 6/0 and N 7/0) and yellowish brown (10YR 5/6) dry; massive in silt loam and fine sandy loam and single grain in sand; soft, very friable, nonsticky and nonplastic very strongly acid when moist and extremely acid when dry; abrupt smooth boundary.

Cg7-52 to 60 inches; stratified dark gray (N 4/0) silt loam and fine sandy loam and yellowish brown (10YR 5/8) sand, gray (N 5/0 and N 6/0) and brownish yellow (10YR 6/8) dry; massive in silt loam and fine sandy loam and single grain in sand; soft, very friable, nonsticky and nonplastic; neutral when moist and strongly acid when dry.

The 10- to 40-inch particle-size control section ranges from 10 to 18 percent clay. These soils have an irregular distribution of organic matter with increasing depth.

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 2 or 3 when moist and dry. It is slightly hard to very hard.

The Cg1 horizon has hue of 10YR to 5Y, value of 3 or 4 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist and dry. It is slightly hard to very hard. It is silt loam, very fine sandy loam, or fine sandy loam.

The Cg2 and Cg3 horizons have hue of 2.5Y, 5Y, or N, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 0 to 2 when moist and dry. They are fine sandy loam or very fine sandy loam.

The Cg4, Cg5, and Cg6 horizons have hue of 2.5Y, 5Y, or N in the silt loam and fine sandy loam and 7.5YR or 10YR in the sand. They have value of 4 or 5 when moist and 5 to 7 when dry in the silt loam and fine sandy loam and value of 4 or 5 when moist and 5 or 6 when dry in the sand. When moist and dry, they have chroma of 0 to 2 in the silt loam and fine sandy loam and 6 to 8 in the sand. They are stratified silt loam, fine sandy loam, and sand. Reaction is very strongly acid, strongly acid, or moderately acid when moist and very strongly acid or strongly acid when dry.

The Cg7 horizon has hue of 5Y or N, value of 2 to 4 when moist and 3 to 6 when dry, and chroma of 0 or 1 when moist and dry. The sand strata have hue of 7.5YR or 10YR and value of 5 when moist and 8 when dry. They are stratified silt loam, fine sandy loam, and sand. Reaction is moderately acid, slightly acid, or neutral when moist and is extremely acid or very strongly acid when dry.

### Everett Series

The Everett series consists of deep and very deep, somewhat excessively drained soils formed in a mixture of volcanic ash and alluvium over glacial outwash and glacial till. These soils are on outwash terraces and moraines. Slopes are 2 to 35 percent. The average annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F.

These soils are sandy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Everett very gravelly sandy loam, in an area of Everett complex, 2 to 8 percent slopes (fig. 6); 4.5 miles east of Blaine, 1,000 feet north and 2,000 feet west of the southeast corner of sec. 2, T. 40 N., R. 1 E.

Oi-4 inches to 0; undecomposed needles and twigs.

E-0 to 2 inches; dark brown (7.5YR 4/2) very gravelly sandy loam, pinkish gray (7.5YR 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine, fine, and medium and common coarse roots; many very fine irregular pores; about 40

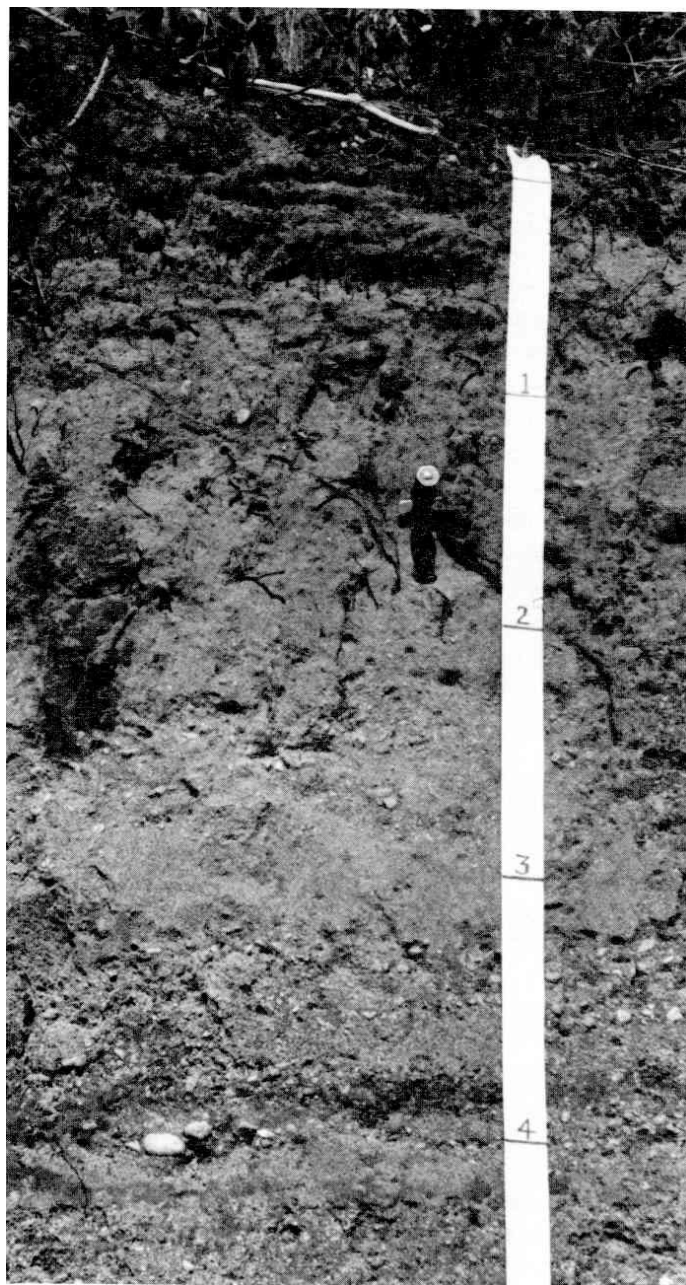


Figure 6.-Profile of Everett very gravelly sandy loam, in an area of Everett complex, 2 to 8 percent slopes. The sandy-skeletal material is at a depth of 18 inches. Depth is marked in feet.

percent pebbles; extremely acid; abrupt wavy boundary.

Bs1-2 to 6 inches; dark brown (7.5YR 3/4) very gravelly sandy loam, dark brown (7.5YR 4/4) dry; dark reddish brown (5YR 3/3) organic stains, moist and dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine, common medium, and few coarse roots; many very fine irregular

- pores; about 40 percent pebbles; NaF pH 10.5; moderately acid; clear irregular boundary.
- Bs2-6 to 11 inches; dark brown (7.5YR 4/4) very gravelly sandy loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and common medium roots; many very fine irregular pores; about 45 percent pebbles and 5 percent cobbles; NaF pH 12.0; moderately acid; clear wavy boundary.
- Bs3-11 to 18 inches; dark brown (7.5YR 4/4) very gravelly sandy loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and common medium roots; many very fine irregular pores; about 50 percent pebbles and 5 percent cobbles; NaF pH 11.5; moderately acid; abrupt wavy boundary.
- 2C1-18 to 28 inches; very gravelly sand; variegated mostly with hue of 10YR; single grain; loose; common very fine and few fine roots; many fine irregular pores; about 55 percent pebbles and 5 percent cobbles; moderately acid; gradual smooth boundary.
- 2C2-28 to 45 inches; variegated extremely gravelly sand; massive; loose, friable, nonsticky and nonplastic; few fine roots; many fine irregular pores; about 65 percent pebbles and 5 percent cobbles; compact in place; moderately acid; clear smooth boundary.
- 2C3-45 to 60 inches; variegated very gravelly sand; single grain; loose; many fine irregular pores; about 55 percent pebbles and 5 percent cobbles; moderately acid.

The part of the profile influenced by volcanic ash and the thickness of the solum range from 14 to 24 inches. The content of rock fragments in the control section ranges from 35 to 60 percent in the upper part and from 50 to 75 percent in the lower part. Some pedons are underlain by dense glacial till or glaciomarine drift at 40 to 60 inches. Other pedons have a perched water table at 40 to 60 inches from December through April.

The E horizon has hue of 5YR or 7.5YR and value of 6 or 7 when dry. Some pedons have an A horizon and do not have an E horizon.

The Bs 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 and dry. The upper part of the Bs horizon is gravelly sandy loam, gravelly loam, or very gravelly sandy loam. The lower part is very gravelly loam or very gravelly sandy loam. Some pedons do not have organic stains in the Bs horizon.

The 2C horizon is variegated very gravelly or

extremely gravelly sand or very gravelly or extremely gravelly loamy sand. The degree of compaction and iron cementation varies but is generally weak.

### Everson Series

The Everson series consists of very deep, poorly drained soils formed in alluvium, lacustrine deposits, and glacial outwash with an admixture of loess. These soils are in depressions on outwash terraces. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are clayey over sandy or sandy-skeletal, mixed, nonacid, mesic Typic Humaquepts.

Typical pedon of Everson silt loam, drained, 0 to 2 percent slopes, about 1.5 miles southeast of Everson, 200 feet south and 100 feet east of the northwest corner of sec. 3, T. 39 N., R. 4 E.

- Ap-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate coarse subangular blocky structure parting to weak medium granular; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; strongly acid; clear smooth boundary.
- Bg-7 to 19 inches; grayish brown (10YR 5/2) silty clay, light gray (10YR 7/2) dry; many large prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; moderate coarse subangular blocky structure; hard, friable, sticky and plastic; many very fine roots; many very fine irregular pores; moderately acid; abrupt smooth boundary.
- 2C1-19 to 29 inches; dark grayish brown (2.5Y 4/2) sand, light gray (2.5Y 7/2) dry; many large prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; moderately acid; clear smooth boundary.
- 2C2-29 to 40 inches; grayish brown (2.5Y 5/2) sand, light gray (2.5Y 7/2) dry; many large prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; about 5 percent pebbles; moderately acid; abrupt smooth boundary.
- 3C3-40 to 54 inches; dark grayish brown (2.5Y 4/2) very gravelly loamy sand, grayish brown (2.5Y 5/2) dry; many medium prominent strong brown (7.5YR 5/6) mottles, reddish yellow (7.5YR 6/6) dry; massive; weakly cemented; slightly hard, friable,

nonsticky and nonplastic; very few fine roots; common very fine irregular pores; about 40 percent pebbles; slightly acid; abrupt smooth boundary.

4C4-54 to 62 inches; olive brown (2.5Y 4/4) gravelly sand, light olive brown (2.5Y 5/4) dry; common large prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; single grain; loose; many very fine irregular pores; about 25 percent pebbles; slightly acid; abrupt smooth boundary.

5C5-62 to 70 inches; grayish brown (2.5Y 5/2) fine sand, light gray (2.5Y 7/2) dry; many large prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; soft, very friable; many very fine irregular pores; slightly acid.

The upper part of the control section has 35 to 45 percent clay. The lower part has 0 to 5 percent clay. The solum is 14 to 26 inches thick. By weighted average, the lower part of the control section has 0 to 10 percent pebbles. Some pedons have gravelly or very gravelly strata below a depth of 40 inches.

The Ap horizon has value of 2 or 3 when moist and 4 or 5 when dry and chroma of 1 or 2 when moist and dry.

The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 when moist and 7 or 8 when dry, and chroma of 1 or 2 when moist and dry. It is silty clay, silty clay loam, clay loam, or clay.

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 and dry. The fine-earth fraction is loamy sand or sand. The weighted average of rock fragments ranges from 0 to 15 percent, although individual subhorizons contain as much as 45 percent pebbles.

### Fishtrap Series

The Fishtrap series consists of very deep, very poorly drained soils formed in herbaceous and woody organic deposits over glaciofluvial deposits. These soils are in depressions on outwash terraces. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are sandy or sandy-skeletal, mixed, euic, mesic Terric Medisaprists.

Typical pedon of Fishtrap muck, drained, 0 to 2 percent slopes, 6 miles southwest of Lynden, 2,600 feet south and 2,100 feet east of the northwest corner of sec. 28, T. 40 N., R. 2 E.

Oa1-0 to 7 inches; very dark grayish brown (10YR 3/2) muck, dark grayish brown (10YR 4/2) dry; moderate coarse subangular blocky structure;

slightly hard, friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many fine irregular pores; moderately acid; clear smooth boundary.

Oa2-7 to 19 inches; very dark brown (10YR 2/2) muck, very dark grayish brown (10YR 3/2) dry; moderate coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many fine irregular pores; strongly acid; abrupt smooth boundary.

2C1-19 to 36 inches; dark grayish brown (2.5Y 4/2) sand, light brownish gray (2.5Y 6/2) dry; many coarse prominent dark yellowish brown (10YR 4/6) mottles, brownish yellow (10YR 6/6) dry; massive; soft, loose, nonsticky and nonplastic; few very fine roots; many fine irregular pores; strongly acid; clear smooth boundary.

2C2-36 to 60 inches; dark gray (N 4/0) sand, gray (N 6/0) dry; single grain; loose; many fine irregular pores; very strongly acid.

The organic material is 16 to 51 inches thick. Fibers are mostly from grasses and sedges, but pedons contain as much as 15 percent wood fragments. The fiber content ranges from 10 to 50 percent when unrubbed and from 2 to 15 percent when rubbed. Thin, discontinuous layers of volcanic ash and diatomaceous earth (0.5 inch to 2 inches thick) are at a depth of 24 to 48 inches in some pedons.

The Oa horizon has hue of 5YR to 10YR or of N, value of 2 to 4 when moist and 2 to 5 when dry, and chroma of 0 to 3 when moist and dry.

The 2C horizon has hue of 2.5Y, 5Y, or N, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 0 to 2 when moist and dry. It is loamy sand, sand, or gravelly sand.

### Gallup Series

The Gallup series consists of very deep, well drained soils formed in a mixture of volcanic ash, loess, unconsolidated glacial till, and colluvium and slope alluvium derived from sandstone and metasedimentary rocks. These soils are on mountain back slopes. Slopes are 30 to 80 percent. The average annual precipitation is 80 to 100 inches, and the mean annual temperature is about 41 degrees F.

These soils are coarse-loamy, mixed Humic Cryorthods.

Typical pedon of Gallup silt loam, cold, 60 to 80 percent slopes, 6 miles southwest of Glacier, 2,000 feet

north and 2,400 feet east of the southwest corner of sec. 33, T. 39 N., R. 6 E.

Oi-12 to 4 inches; undecomposed needles, twigs, leaves, and moss.

Oa-4 inches to 0; decomposed needles, twigs, and leaves; many very fine and medium and common coarse roots.

E-0 to 3 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 5/2) dry; massive; very hard, very firm, slightly sticky and slightly plastic; common very fine, fine, medium, and coarse roots; common very fine irregular pores; about 5 percent pebbles; NaF pH 9.0; extremely acid; abrupt smooth boundary.

Bhs-3 to 6 inches; dark reddish brown (5YR 3/3) gravelly silt loam, dark brown (7.5YR 4/4) dry; dark reddish brown (5YR 2/2) organic stains on faces of peds, dark reddish brown (5YR 3/3) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and nonplastic; weakly smeary; many very fine and fine and common medium and coarse roots; common very fine irregular pores; about 15 percent pebbles and 5 percent cobbles; NaF pH 10.5; very strongly acid; clear smooth boundary.

Bs1-6 to 14 inches; yellowish red (5YR 4/6) gravelly loam, strong brown (7.5YR 5/6) dry; dark reddish brown (5YR 2/2) organic stains on faces of peds, dark reddish brown (5YR 3/2) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium roots; common very fine irregular pores; about 20 percent pebbles and 5 percent cobbles; NaF pH 11.0; very strongly acid; clear wavy boundary.

Bs2-14 to 27 inches; dark brown (7.5YR 3/4) gravelly loam, strong brown (7.5YR 5/6) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few medium roots; common very fine irregular pores; about 20 percent pebbles, 5 percent cobbles, and 5 percent stones; NaF pH 12.0; very strongly acid; abrupt wavy boundary.

BC-27 to 39 inches; dark yellowish brown (10YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few fine and medium roots; common very fine irregular pores; about 30 percent unweathered pebbles and 15 percent weathered pebbles; NaF pH 11.5; very strongly acid; clear smooth boundary.

C1-39 to 51 inches; dark yellowish brown (10YR 4/6) gravelly loam, brownish yellow (10YR 6/6) dry; massive; soft, very friable, nonsticky and nonplastic;

weakly smeary; few fine roots; common very fine irregular pores; about 20 percent unweathered pebbles and 10 percent weathered pebbles; NaF pH 12.0; very strongly acid; clear smooth boundary.

C2-51 to 60 inches; dark yellowish brown (10YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine irregular pores; about 20 percent weathered pebbles; NaF pH 12.0; very strongly acid.

The thickness of the solum is 25 to 39 inches. The content of unweathered rock fragments in the control section is 20 to 35 percent and that of weathered fragments is 5 to 25 percent.

The E horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 1 or 2 when moist and dry.

The Bhs and Bs horizons have hue of 5YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 3 to 6 when moist and dry. They are loam, silt loam, gravelly loam, or gravelly silt loam.

The BC 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 dry. It is gravelly loam or gravelly silt loam.

The C 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 6 when moist and dry. It is gravelly loam, gravelly silt loam, or gravelly sandy loam.

### Getchell Series

The Getchell series consists of moderately deep, moderately well drained soils formed in an admixture of volcanic ash and colluvium over glacial till. These soils are on high mountain back slopes and plateaus. Slopes are 3 to 60 percent. The average annual precipitation is 70 to 85 inches, and the mean annual air temperature is about 42 degrees F.

These soils are coarse-loamy, mixed, ortstein Typic Cryorthods.

Typical pedon of Getchell loam, 3 to 30 percent slopes, 4 miles southwest of Van Zandt, 800 feet south and 1,400 feet west of the northeast corner of sec. 22, T. 38 N., R. 4 E.

Oi-5 to 4 inches; undecomposed needles, twigs, cones, and dead moss.

Oa-4 inches to 0; decomposed needles, twigs, cones, and roots and rotted wood; many very fine and fine and common medium roots.

E-0 to 1 inch; dark gray (7.5YR 4/1) loam, gray (7.5YR 6/1) dry; weak fine subangular blocky structure;

slightly hard, firm, nonsticky and nonplastic; weakly smeary; common very fine and fine roots; common very fine irregular pores; about 5 percent hard pebbles and 10 percent soft pebbles; NaF pH 10.5; very strongly acid; abrupt wavy boundary.

Bhs-1 to 4 inches; dark brown (7.5YR 4/4) loam, light brown (7.5YR 6/4) dry; dark reddish brown (5YR 3/3) organic stains, dark reddish brown (5YR 3/4) dry; moderate fine subangular blocky structure; soft, friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium roots; common very fine irregular pores; about 5 percent hard pebbles and 10 percent soft pebbles; NaF pH 11.5; very strongly acid; abrupt smooth boundary.

Bs-4 to 12 inches; dark brown (7.5YR 4/4) sandy loam, strong brown (7.5YR 4/6) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium and few coarse roots; common very fine irregular pores; about 5 percent hard pebbles and 20 percent soft pebbles; NaF pH 11.0; strongly acid; clear smooth boundary.

BC-12 to 36 inches; brown (10YR 5/3) sandy loam, light gray (10YR 7/2) dry; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium and many coarse roots; common very fine irregular pores; about 10 percent hard pebbles and 20 percent soft pebbles; NaF pH 11.0; strongly acid; clear smooth boundary.

2Cd-36 to 60 inches; yellowish brown (10YR 5/4), dense glacial till that breaks to sandy loam, very pale brown (10YR 7/3) dry; massive; hard, firm, nonsticky and nonplastic; about 10 percent hard pebbles and 20 percent soft pebbles; strongly acid.

The depth to dense, compact glacial till is 20 to 40 inches. The content of rock fragments in the control section ranges from 5 to 15 percent hard pebbles and from 10 to 20 percent soft pebbles.

The E horizon has hue of 5YR to 10YR, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 1 or 2 when moist and 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 4 when moist and dry. It is loam or silt loam.

The Bs horizon has hue of 7.5YR or 10YR, value of 4 to 6 when moist and dry, and chroma of 3 to 6 when moist and dry. It is loam, silt loam, or sandy loam.

The BC 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 to 4 when moist and dry. It is loam or sandy loam.

The 2Cd horizon has value of 4 or 5 when moist and chroma of 2 to 4 when moist and dry. It is dense glacial

till that breaks to loam or sandy loam.

### Hale Series

The Hale series consists of very deep, somewhat poorly drained soils formed in an admixture of loess and volcanic ash over glacial outwash. These soils are on outwash terraces. Slopes are 0 to 2 percent. The average annual precipitation is 40 to 55 inches, and the mean annual air temperature is 50 degrees F.

These soils are coarse-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Haplorthods.

Typical pedon of Hale silt loam, drained, 0 to 2 percent slopes, 1.5 miles northwest of Lynden, 2,500 feet north and 100 feet west of the southeast corner of sec. 8, T. 40 N., R. 3 E.

Ap-0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine irregular and few fine tubular pores; NaF pH 9.4; moderately acid; abrupt smooth boundary.

Bs1-10 to 14 inches; mottled olive gray (5Y 5/2), dark brown (7.5YR 3/4), and strong brown (7.5YR 4/6) silt loam, light gray (5Y 7/2), strong brown (7.5YR 5/6), and reddish yellow (7.5YR 6/6) dry; moderate medium subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular and few very fine tubular pores; moderately acid; clear smooth boundary.

Bs2-14 to 19 inches; mottled grayish brown (2.5Y 5/2), dark brown (7.5YR 3/4), and strong brown (7.5YR 4/6) loam, light gray (2.5Y 7/2), strong brown (7.5YR 5/6), and reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular and few very fine tubular pores; strongly acid; clear smooth boundary.

Bs3-19 to 24 inches; mottled olive gray (5Y 5/2), dark brown (7.5YR 4/4), and strong brown (7.5YR 4/6) loam, light gray (5Y 7/2), brown (7.5YR 5/4), and reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; strongly acid; abrupt smooth boundary.

Bw-24 to 26 inches; mottled olive gray (5Y 4/2 and 5/2) and strong brown (7.5YR 4/6) loam, grayish brown (2.5Y 5/2), light gray (2.5Y 7/2), and strong brown (7.5YR 5/6) dry; moderate medium

subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; strongly acid; abrupt smooth boundary.

2C1-26 to 38 inches; dark grayish brown (2.5Y 4/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; common medium prominent strong brown (7.5YR 4/6) mottles, strong brown (7.5YR 5/8) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; strongly acid; abrupt smooth boundary.

2C2-38 to 60 inches; sand that is dominantly dark grayish brown (2.5Y 4/2) but is variegated, light brownish gray (2.5Y 6/2) dry; single grain; loose; few very fine roots; many very fine irregular pores; slightly acid.

The thickness of the solum is 15 to 30 inches. By weighted average, the upper part of the particle-size control section has 10 to 18 percent clay and 0 to 10 percent pebbles and the lower part has 0 to 5 percent clay and 0 to 15 percent pebbles, although individual subhorizons contain as much as 25 percent pebbles.

The A horizon has value of 5 or 6 when dry and chroma of 2 or 3 when moist and dry. The Bs horizon has dominant hue of 2.5Y or 5Y, value of 4 to 6 when moist and 5 to 8 when dry, and chroma of 2 or 3 when moist and dry. It is loam, silt loam, or fine sandy loam and contains 0 to 15 percent ortstein concretions.

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 to 4 when moist and dry. It is massive or single grain. It is loamy fine sand, loamy sand, sand, gravelly loamy sand, or gravelly sand.

### Hallenton Series

The Hallenton series consists of very deep, very poorly drained soils formed in a mixture of volcanic ash, loess, and glaciomarine drift. These soils are in ponded areas on glaciomarine drift plains. Slopes are 0 to 1 percent. The average annual precipitation is 30 to 40 inches, and the mean annual air temperature is about 50 degrees F.

These soils are fine-loamy, mixed, nonacid, mesic Typic Haplaquepts.

Typical pedon of Hallenton silt loam, 0 to 1 percent slopes, 8 miles east of Blaine, 1,400 feet south and 1,500 feet east of the northwest corner of sec. 4, T. 40 N., R. 2 E.

A-0 to 11 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and

nonplastic; common very fine roots; few fine irregular pores; moderately acid; clear smooth boundary.

Bg-11 to 19 inches; light brownish gray (2.5Y 6/2) silt loam, white (2.5Y 8/2) dry; few medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; strongly acid; clear smooth boundary.

Cg-19 to 60 inches; olive (5Y 5/3) silt loam, white (5Y 8/2) dry; many coarse prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; very hard, firm, slightly sticky and plastic; strongly acid.

The thickness of the solum is 14 to 30 inches. By weighted average, the control section has 18 to 30 percent clay and 0 to 10 percent pebbles, although individual horizons contain 0 to 25 percent pebbles.

The A 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 or 3 when moist and dry.

The Bg horizon has hue of 10YR or 2.5Y, value of 5 to 7 when moist and 6 to 8 when dry, and chroma of 2 or 3 when moist and dry. It is silt loam or loam.

The Cg horizon has hue of 2.5Y, 5Y, or N, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 0 to 3 when moist and dry. It is loam, clay loam, silt loam, or silty clay loam.

### Hannegan Series

The Hannegan series consists of shallow, well drained soils formed in a mixture of volcanic ash, loess, and colluvium derived from phyllite and sandstone. These soils are on mountain shoulder slopes. Slopes are 15 to 40 percent. The average annual precipitation is 90 to 110 inches, and the mean annual air temperature is about 40 degrees F.

These soils are loamy-skeletal, mixed Humic Lithic Cryorthods.

Typical pedon of Hannegan very gravelly loam, 15 to 40 percent slopes, 4 miles southwest of Glacier, 2,500 feet south and 2,000 feet west of the northeast corner of sec. 26, T. 39 N., R. 6 E.

Oi-5 to 4 inches; undecomposed needles, leaves, and twigs.

Oa-4 inches to 0; decomposed needles, leaves, and twigs; many very fine, fine, and medium roots.

E1-0 to 1 inch; dark brown (7.5YR 3/2) very gravelly loam, pinkish gray (7.5YR 7/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores;

about 30 percent hard pebbles, 15 percent hard cobbles, and 20 percent weathered pebbles; extremely acid; clear smooth boundary.

E2-1 to 5 inches; dark reddish brown (5YR 3/2) very gravelly loam, reddish gray (5YR 5/2) dry; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; about 30 percent soft pebbles; very strongly acid; clear smooth boundary.

Bhs-5 to 12 inches; dark yellowish brown (10YR 3/4) very cobbly loam, light yellowish brown (10YR 6/4) dry; dark brown (7.5YR 3/2) organic stains, dark brown (7.5YR 4/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine roots; many very fine irregular pores; about 20 percent hard pebbles, 30 percent hard cobbles, and 20 percent weathered pebbles; NaF pH 11.5; very strongly acid; clear smooth boundary.

Bs-12 to 17 inches; dark yellowish brown (10YR 3/4) and pale brown (10YR 6/3) very gravelly loam, light yellowish brown (10YR 6/4) and very pale brown (10YR 8/3) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine roots; many very fine irregular pores; about 30 percent hard pebbles, 10 percent hard cobbles, and 10 percent weathered pebbles; NaF pH 12.0; very strongly acid; abrupt smooth boundary.

R-17 inches; fractured phyllite.

The depth to phyllite and the thickness of the part of the profile influenced by volcanic ash range from 14 to 20 inches. The content of rock fragments in the particle-size control section is 25 to 35 percent hard pebbles, 10 to 30 percent hard cobbles, and 10 to 20 percent weathered pebbles.

The E horizon has hue of 5YR to 10YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 2 or 3 when moist and dry.

The Bhs 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 very gravelly loam or very cobbly loam.

The Bs horizon has hue of 7.5YR to 2.5Y, value of 3 to 6 when moist and 5 to 8 when dry, and chroma of 3 or 4 when moist and dry. It is very gravelly loam or very cobbly loam.

### Hartnit Series

The Hartnit series consists of moderately deep, well drained soils formed in a mixture of volcanic ash, glacial till, and colluvium derived from sandstone and

metasedimentary rocks. These soils are on mountain back slopes and plateaus. Slopes are 5 to 80 percent. The average annual precipitation is 70 to 90 inches, and the mean air temperature is about 42 degrees F.

These soils are coarse-loamy, mixed Typic Cryorthods.

Typical pedon of Hartnit loam, in an area of Saar-Hartnit complex, 5 to 40 percent slopes; 4 miles southwest of Glacier, 500 feet north and 1,500 feet west of the southeast corner of sec. 22, T. 39 N., R. 6 E.

Oa-3 inches to 0; decomposed needles, leaves, and twigs; many very fine, fine, medium, and coarse roots.

E-0 to 4 inches; dark brown (7.5YR 4/2) loam, pinkish gray (7.5YR 7/2) dry; massive; slightly hard, very friable, nonsticky and nonplastic; many very fine, fine, medium, and coarse roots; many very fine irregular pores; about 5 percent hard pebbles and 5 percent weathered pebbles; very strongly acid; abrupt wavy boundary.

Bhs-4 to 10 inches; dark brown (7.5YR 4/6) loam, strong brown (7.5YR 5/6) dry; dark reddish brown (5YR 3/3) organic stains, dark brown (7.5YR 4/4) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; about 10 percent hard pebbles and 10 percent weathered pebbles; NaF pH 10.0; strongly acid; clear irregular boundary.

Bs-10 to 17 inches; dark yellowish brown (10YR 4/6) loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine and fine roots; many very fine irregular pores; about 10 percent hard pebbles and 15 percent weathered pebbles; NaF pH 11.5; moderately acid; clear smooth boundary.

BC-17 to 27 inches; olive brown (2.5Y 4/4) gravelly loam, pale yellow (2.5Y 7/4) dry; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; weakly smeary; few very fine roots; many very fine irregular pores; about 20 percent hard pebbles and 20 percent weathered pebbles; NaF pH 12.0; moderately acid; clear smooth boundary.

C1-27 to 36 inches; dark yellowish brown (10YR 3/4) very gravelly loam, light olive brown (2.5Y 5/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine irregular pores; about 40 percent hard pebbles and 20 percent soft pebbles; moderately acid; clear smooth boundary.

C2-36 to 39 inches; olive brown (2.5Y 4/4) very gravelly loam, light gray (2.5Y 7/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine irregular pores; about 50 percent hard pebbles and 20 percent weathered pebbles; NaF pH 11.0; moderately acid; clear smooth boundary.  
R-39 inches; sandstone.

The depth to sandstone or metasedimentary rock and the thickness of the part of the profile influenced by volcanic ash are 20 to 40 inches. The content of hard rock fragments in the particle-size control section ranges from 15 to 35 percent, although individual horizons contain as much as 50 percent hard rock fragments. The content of weathered rock fragments ranges from 0 to 25 percent by weighted average.

The E horizon has hue of 5YR to 10YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 1 or 2 when moist or dry.

The Bhs and Bs horizons have hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist and dry. They are gravelly loam or gravelly silt loam.

The C 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 and dry. It is gravelly loam, gravelly silt loam, or very gravelly loam.

### Heisler Series

The Heisler series consists of very deep, well drained soils formed in a mixture of volcanic ash and loess over colluvium derived from glacial till high in content of phyllite. These soils are on mountain back slopes. Slopes are 8 to 60 percent. The average annual precipitation is 50 to 70 inches, and the mean annual air temperature is about 47 degrees F.

These soils are loamy-skeletal, mixed, mesic Typic Haplothods.

Typical pedon of Heisler very gravelly silt loam, 30 to 60 percent slopes, 4.5 miles northwest of Wickersham, 1,300 feet south and 2,300 feet west of the northeast corner of sec. 23, T. 37 N., R. 5 E.

Oi-4 to 3 inches; undecomposed needles, leaves, and twigs.

Oa-3 inches to 0; decomposed forest litter.

E-0 to 1 inch; gray (5YR 6/1) silt loam, pinkish gray (7.5YR 7/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine roots; common very fine irregular pores; about 10 percent pebbles; NaF pH 10.0; very strongly acid; abrupt smooth boundary.

Bs1-1 to 6 inches; dark brown (7.5YR 4/4) very gravelly silt loam, light brown (7.5YR 6/4) dry; dark reddish brown (5YR 3/3) organic stains, reddish brown (5YR 5/3) dry; weak medium subangular blocky structure parting to weak medium granular; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine and fine roots; common very fine and fine irregular pores; about 35 percent pebbles and 15 percent cobbles; NaF pH 11.5; strongly acid; gradual wavy boundary.

Bs2-6 to 24 inches; yellowish brown (10YR 5/6) very gravelly silt loam, light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, and medium roots; common very fine and fine irregular pores; about 30 percent channers, 20 percent pebbles, and 10 percent cobbles; NaF pH 11.0; strongly acid; gradual smooth boundary.

BC-24 to 32 inches; light olive brown (2.5Y 5/4) extremely channery loam, light gray (2.5Y 7.2) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine and few medium roots; common very fine and fine irregular pores; about 40 percent channers, 10 percent pebbles, and 15 percent cobbles; NaF pH 10.5; moderately acid; clear smooth boundary.

C1-32 to 38 inches; pale olive (5Y 6/4) extremely channery sandy loam, light gray (5Y 7/2) dry; massive; soft, friable, nonsticky and slightly plastic; weakly smeary; few very fine and fine roots; common very fine and fine irregular pores; about 55 percent channers, 10 percent pebbles, and 10 percent cobbles; NaF pH 10.5; moderately acid; clear smooth boundary.

C2-38 to 60 inches; pale olive (5Y 6/3) extremely channery sandy loam, light gray (5Y 7/2) dry; massive; soft, friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; common very fine and fine irregular pores; about 55 percent channers, 10 percent pebbles, and 15 percent cobbles; NaF pH 10.5; moderately acid.

The thickness of the solum is 22 to 35 inches. The content of rock fragments in the control section ranges from 40 to 60 percent channers and pebbles and from 5 to 15 percent cobbles.

The E horizon has hue of 5YR to 10YR, value of 3 to 6 when moist and 4 to 7 when dry, and chroma of 2 to 4 when moist and dry. Some pedons do not have an E horizon.

The Bs horizon has hue of 5YR to 10YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4

to 6 when moist. It is very channery loam, very channery silt loam, or very channery fine sandy loam.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 when moist and 6 or 7 when dry, and chroma of 2 to 4 when moist and dry. It is very channery or extremely channery loam or sandy loam.

### Hinker Series

The Hinker series consists of moderately deep, well drained soils formed in a mixture of volcanic ash, loess, and colluvium derived dominantly from phyllite. These soils are on high mountain shoulder slopes. Slopes are 5 to 60 percent. The average annual precipitation is 85 to 100 inches, and the mean annual air temperature is about 41 degrees F.

These soils are loamy-skeletal, mixed Humic Cryorthods.

Typical pedon of Hinker very channery silt loam, 30 to 60 percent slopes, 1,200 feet north and 750 feet west of the southeast corner of sec. 8, T. 37 N., R. 6 E.

Oi-15 to 12 inches; undecomposed needles, leaves, and twigs.

Oa-12 inches to 0; decomposed organic mat; many very fine, fine, medium, and coarse roots.

E1-0 to 4 inches; pinkish gray (7.5YR 6/2) very channery loam, pinkish gray (7.5YR 7/2) dry; massive; soft, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; about 40 percent channers and 5 percent cobbles; extremely acid; clear smooth boundary.

E2-4 to 6 inches; brown (7.5YR 5/3) very channery silt loam, pinkish gray (7.5YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; about 40 percent channers and 5 percent cobbles; extremely acid; abrupt smooth boundary.

Bhs1-6 to 11 inches; dark brown (7.5YR 4/4) very channery silt loam, brown (7.5YR 5/4) dry; dark reddish brown (5YR 3/2) organic stains, moist and dry, on 60 percent of faces of peds; moderate very coarse subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; about 40 percent channers; NaF pH 9.6; extremely acid; clear irregular boundary.

Bhs2-11 to 15 inches; dark brown (7.5YR 4/4) very channery loam, light yellowish brown (10YR 6/4) dry; dark reddish brown (5YR 2/2) organic stains, dark reddish brown (5YR 3/2) dry, on 40 percent of faces of peds; moderate very coarse subangular

blocky structure; slightly hard, firm, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; about 35 percent channers; NaF pH 12.0; very strongly acid; clear irregular boundary.

Bhs3-15 to 21 inches; dark brown (7.5YR 4/4) and yellowish brown (10YR 5/4) very channery silt loam, yellowish brown (10YR 5/6) and light yellowish brown (10YR 6/4) dry; very dusky red (2.5YR 2/2) organic stains, dusky red (2.5YR 3/2) dry, on 30 percent of faces of peds; moderate very coarse subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; many very fine irregular pores; about 50 percent channers; NaF pH 11.5; very strongly acid; abrupt wavy boundary.

2R-21 inches; unweathered phyllite.

The depth to phyllite and the thickness of the part of the profile influenced by volcanic ash are 20 to 40 inches. The control section contains from 35 to 65 percent hard rock fragments and from 15 to 35 percent soft rock fragments.

The E horizon has hue of 5YR to 10YR, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 2 or 3 when moist and dry. The Bhs horizon has hue of 5YR to 10YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 4 to 6 when moist and 4 to 8 when dry. It is very cobbly loam, very cobbly silt loam, very channery loam, or very channery silt loam.

### Hovde Series

The Hovde series consists of very deep, poorly drained soils formed in marine sediments and gravelly coastal beach deposits. These soils are on marine terraces. Slopes are 0 to 2 percent. The average annual precipitation is 25 to 40 inches, and the mean annual air temperature is about 50 degrees F.

These soils are sandy-skeletal, mixed, mesic Aeric Haplaquents.

Typical pedon of Hovde silt loam, 0 to 2 percent slopes, 1.5 miles west of Marietta, 1,000 feet south and 2,300 feet east of the northwest corner of sec. 18, T. 38 N., R. 2 E.

Oi-1 inch to 0; leaves and twigs.

A-0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (2.5Y 6/2) dry; few fine prominent strong brown (7.5YR 5/6) mottles, reddish yellow (7.5YR 6/6) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, medium, and coarse roots; many very fine irregular

pores; about 10 percent pebbles; moderately acid; abrupt smooth boundary.

2C1-9 to 13 inches; very dark grayish brown (2.5Y 3/2) extremely gravelly coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose; many very fine roots; many very fine irregular pores; about 60 percent pebbles; moderately acid; abrupt smooth boundary.

2C2-13 to 29 inches; dark brown (10YR 4/3) very gravelly coarse sand, brown (10YR 5/3) dry; single grain; loose; common very fine roots; many very fine irregular pores; about 40 percent pebbles; moderately acid; abrupt smooth boundary.

2C3-29 to 39 inches; dark grayish brown (2.5Y 4/2) very gravelly coarse sand, grayish brown (2.5Y 5/2) dry; single grain; loose; common very fine roots; many very fine irregular pores; about 45 percent pebbles; moderately acid; clear smooth boundary.

2C4-39 to 60 inches; very dark grayish brown (10YR 3/2) very gravelly sand, dark grayish brown (10YR 4/2) dry; single grain; loose; few very fine roots; many very fine irregular pores; about 50 percent pebbles; strongly acid.

The content of rock fragments in the control section ranges from 40 to 55 percent by weighted average. The A horizon has hue of 10YR or 2.5Y and value of 3 or 4 when moist and 5 or 6 when dry. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 or 3 when moist and dry. It is very gravelly sand, very gravelly coarse sand, extremely gravelly sand, or extremely gravelly coarse sand.

### Hozomeen Series

The Hozomeen series consists of shallow, moderately well drained soils formed in a mixture of loess, volcanic ash, and colluvium over glacial till. These soils are on mountain back slopes. Slopes are 20 to 45 percent. The average annual precipitation is 80 to 95 inches, and the mean annual air temperature is about 43 degrees F.

These soils are loamy-skeletal, mixed, shallow Typic Cryorthods.

Typical pedon of Hozomeen gravelly loam, 20 to 45 percent slopes, 7 miles southeast of Van Zandt, 2,000 feet north and 300 feet west of the southeast corner of sec. 29, T. 38 N., R. 6 E.

Oi-6 to 5 inches; undecomposed needles, leaves, and twigs.

Oa-5 inches to 0; decomposed needles, leaves, and twigs; common very fine and many fine and medium roots.

E-0 to 1 inch; dark reddish brown (5YR 3/2) gravelly fine sandy loam, reddish gray (5YR 5/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, and medium roots; many very fine irregular pores; about 20 percent pebbles; extremely acid; abrupt irregular boundary.

Bhs-1 to 4 inches; dark reddish brown (5YR 3/3) gravelly loam, reddish brown (5YR 5/3) dry; dark reddish brown (2.5YR 3/4) organic stains on faces of peds, dark reddish brown (5YR 3/3) dry; weak fine subangular blocky structure parting to weak medium granular; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few medium roots; many very fine irregular pores; about 25 percent pebbles; NaF pH 9.4; very strongly acid; clear smooth boundary.

Bs1-4 to 8 inches; dark reddish brown (5YR 3/4) very gravelly loam, yellowish red (5YR 4/6) dry; weak medium subangular blocky structure parting to weak medium granular; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and few medium roots; many very fine irregular pores; about 40 percent pebbles; NaF pH 10.5; very strongly acid; clear smooth boundary.

Bs2-8 to 13 inches; dark brown (7.5YR 3/4) very gravelly loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; weakly smeary; common very fine and few fine and medium roots; many very fine irregular pores; about 40 percent pebbles and 5 percent cobbles; NaF pH 11.5; strongly acid; clear smooth boundary.

BC-13 to 18 inches; strong brown (7.5YR 4/6) very gravelly loam, strong brown (7.5YR 5/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; very few very fine and fine roots; common very fine irregular pores; about 50 percent pebbles; NaF pH 10.5; strongly acid; abrupt smooth boundary.

2Cd-18 to 60 inches; olive brown (2.5Y 4/4), dense, compact glacial till that breaks to gravelly loam, light yellowish brown (2.5Y 6/4) dry; massive; hard, firm, nonsticky and nonplastic; weakly smeary; about 30 percent pebbles; NaF pH 10.0; strongly acid.

The depth to dense, compact glacial till and the thickness of the part of the profile influenced by volcanic ash range from 14 to 20 inches. The content of rock fragments in the control section ranges from 35 to 45 percent.

The E horizon has hue of 5YR to 10YR, value of 3 to 6 when moist and 5 to 7 when dry, and chroma of 1 to 3 when moist and dry.

The Bh<sub>s</sub> and Bs horizons have hue of 5YR to 7.5YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 to 6 when moist and dry. They are gravelly loam, gravelly silt loam, very gravelly loam, or very gravelly silt loam.

The BC horizon has hue of 7.5YR to 2.5Y and value of 3 to 5 when moist and 4 to 6 when dry. It is very gravelly loam or very gravelly silt loam.

The 2Cd horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and dry, and chroma of 2 to 4 when moist and dry. It is dense glacial till that breaks to gravelly loam or very gravelly loam.

### Jackman Series

The Jackman series consists of very deep, well drained soils formed in a mixture of volcanic ash, colluvium, slope alluvium, and glacial till derived from dunite. These soils are on mountain back slopes. Slopes are 30 to 60 percent. The average annual precipitation is 75 to 90 inches, and the mean annual air temperature is about 42 degrees F.

These soils are loamy-skeletal, serpentinitic Typic Cryorthods.

Typical pedon of Jackman gravelly silt loam, 30 to 60 percent slopes, 10.5 miles east of Wickersham, 1,600 feet north and 2,600 feet east of the southwest corner of sec. 36, T. 37 N., R. 6 E.

Oi-2 inches to 0; undecomposed needles, leaves, and twigs.

Bs1-0 to 9 inches; dark yellowish brown (10YR 4/4) gravelly silt loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine irregular pores; about 20 percent pebbles; NaF pH 10.5; strongly acid; abrupt smooth boundary.

Bs2-9 to 15 inches; yellowish brown (10YR 5/6) very gravelly silt loam, brownish yellow (10YR 6/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few medium roots; many very fine irregular pores; about 30 percent pebbles; NaF pH 9.8; moderately acid; clear smooth boundary.

Bs3-15 to 24 inches; strong brown (7.5YR 5/6) very gravelly silt loam, reddish yellow (7.5YR 6/6) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few medium roots; many very fine irregular pores; about 45 percent pebbles; NaF pH 10.0; moderately acid; abrupt smooth boundary.

BC-24 to 32 inches; yellowish brown (10YR 5/6) very gravelly loam, brownish yellow (10YR 6/6) dry; massive; soft, friable, nonsticky and nonplastic; weakly smeary; few fine roots; common very fine irregular pores; about 45 percent pebbles and 5 percent cobbles; NaF pH 10.0; moderately acid; clear smooth boundary.

C-32 to 60 inches; dark brown (7.5YR 4/4) very gravelly loam, reddish yellow (7.5YR 6/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine irregular pores; about 55 percent pebbles; NaF pH 10.0; moderately acid.

The thickness of the solum is 15 to 36 inches. The content of rock fragments in the control section ranges from 35 to 60 percent. It includes 0 to 5 percent cobbles.

Some pedons have an E horizon above the Bs<sub>1</sub> horizon. The E horizon is less than 0.5 inch thick.

The Bs horizon has hue of 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 and dry. It is dominantly very gravelly loam or very gravelly silt loam. In some pedons, however, the upper part is gravelly silt loam.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist and dry. It is very gravelly loam or very gravelly sandy loam.

### Jorgensen Series

The Jorgensen series consists of very deep, somewhat excessively drained soils formed in a mixture of loess, volcanic ash, and glacial outwash derived from dunite. These soils are on outwash terraces. Slopes are 3 to 15 percent. The mean annual precipitation is 90 to 100 inches, and the mean annual air temperature is about 42 degrees F.

These soils are sandy-skeletal, serpentinitic Humic Cryorthods.

Typical pedon of Jorgensen gravelly silt loam, 3 to 15 percent slopes, 10 miles southeast of Van Zandt, 2,600 feet south and 700 feet west of the northeast corner of sec. 16, T. 37 N., R. 6 E.

Oi-18 to 7 inches; undecomposed needles, leaves, and twigs; common very fine, fine, and medium roots.

Oa-7 inches to 0; decomposed organic mat; many very fine and common fine and medium roots.

E-0 to 3 inches; brown (7.5YR 5/2) gravelly silt loam, pinkish gray (7.5YR 6/2) dry; massive; slightly hard, friable, slightly sticky and nonplastic; common very

fine and few fine and medium roots; few very fine irregular pores; about 25 percent pebbles; extremely acid; abrupt wavy boundary.

Bhs1-3 to 5 inches; dark brown (7.5YR 4/4) gravelly silt loam, strong brown (7.5YR 5/6) dry; black (5YR 2/1) organic stains on 80 percent of the soil matrix, dark reddish brown (5YR 3/2) dry; strong medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine, fine, and medium roots; few very fine irregular pores; about 20 percent pebbles; extremely acid; clear wavy boundary.

Bhs2-5 to 8 inches; dark brown (7.5YR 3/4) very gravelly loam, strong brown (7.5YR 5/6) dry; reddish brown (5YR 4/4) organic stains on faces of peds, strong brown (7.5YR 4/6) dry; strong very coarse subangular blocky structure; hard, firm, nonsticky and nonplastic; weakly smeary; few very fine, fine, and medium roots; few very fine irregular pores; about 25 percent pebbles and 10 percent cobbles; NaF pH 12.0; very strongly acid; clear irregular boundary.

Bs1-8 to 13 inches; dark yellowish brown (10YR 4/6) very gravelly sandy loam, brownish yellow (10YR 6/6) dry; moderate medium subangular blocky structure parting to moderate coarse granular; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine and very few fine roots; common very fine irregular pores; about 30 percent pebbles and 15 percent cobbles; NaF pH 12.0; moderately acid; clear irregular boundary.

Bs2-13 to 19 inches; dark yellowish brown (10YR 4/4) extremely gravelly sandy loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine and very few fine roots; common fine irregular pores; about 50 percent pebbles and 15 percent cobbles; NaF pH 12.0; moderately acid; clear wavy boundary.

C1-19 to 22 inches; olive brown (2.5Y 4/4) extremely gravelly loamy sand, light olive brown (2.5Y 5/4) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; very few very fine roots; common very fine irregular pores; about 50 percent pebbles and 20 percent cobbles; NaF pH 12.0; moderately acid; abrupt wavy boundary.

C2-22 to 60 inches; olive brown (2.5Y 4/4) extremely gravelly loamy sand, light yellowish brown (2.5Y 6/4) dry; single grain; soft, very friable, nonsticky and nonplastic; very few very fine roots; many very fine and fine irregular pores; about 50 percent pebbles and 20 percent cobbles; NaF pH 12.0; moderately acid.

The thickness of the solum is 10 to 25 inches. The depth to bedrock and the thickness of the part of the profile influenced by volcanic ash are more than 60 inches. The content of rock fragments in the control section ranges from 40 to 60 percent pebbles and 10 to 20 percent cobbles.

The E horizon has value of 5 or 6 when moist and 6 or 7 when dry and chroma of 2 to 4 when moist and dry.

The Bhs1 horizon has chroma of 4 to 6 when moist and 6 to 8 when dry. It is gravelly loam or gravelly silt loam. The organic stains have value of 2 or 3 when moist and 3 or 4 when dry and chroma of 1 or 2 when moist and 2 to 4 when dry. The Bhs2 horizon has value of 3 or 4 when moist and 4 or 5 when dry and chroma of 4 to 6 when moist and dry. It is very gravelly loam or very gravelly fine sandy loam.

The Bs horizon has chroma of 4 to 6 when moist and dry. It is very gravelly sandy loam or very gravelly fine sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist and dry. It is very gravelly or extremely gravelly loamy sand or very gravelly or extremely gravelly sand.

### Jug Series

The Jug series consists of very deep, somewhat excessively drained soils formed in a mixture of volcanic ash and glacial outwash over glacial outwash. These soils are on outwash terraces. Slopes are 3 to 15 percent. The average annual precipitation is 70 to 80 inches, and the mean annual air temperature is about 44 degrees F.

These soils are sandy-skeletal, mixed, frigid Humic Haplorthods.

Typical pedon of Jug very gravelly loam, 3 to 15 percent slopes, 10 miles east of Van Zandt, 800 feet south and 2,200 feet east of the northwest corner of sec. 26, T. 38 N., R. 6 E.

Oi-5 to 4 inches; undecomposed needles, leaves, and twigs.

Oa-4 inches to 0; decomposed needles, leaves, and twigs; many very fine, fine, medium, and coarse roots.

E-0 to 2 inches; dark brown (7.5YR 4/2) very gravelly loam, pinkish gray (7.5YR 7/2) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, medium, and coarse roots; common fine irregular pores; about 40 percent pebbles; NaF

pH 10.0; very strongly acid; abrupt smooth boundary.

Bhs-2 to 6 inches; dark brown (7.5YR 4/4) very gravelly loam, strong brown (7.5YR 5/6) dry; dark reddish brown (5YR 3/3) organic stains, dark reddish brown (5YR 3/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium and few coarse roots; common fine irregular pores; about 50 percent pebbles; NaF pH 11.5; very strongly acid; abrupt smooth boundary.

Bs-6 to 9 inches; strong brown (7.5YR 5/6) very gravelly loam, reddish yellow (7.5YR 6/6) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium and few coarse roots; about 50 percent pebbles; NaF pH 11.5; strongly acid; clear wavy boundary.

BC-9 to 25 inches; yellowish brown (10YR 5/4) very gravelly sandy loam, very pale brown (10YR 7/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few fine and medium roots; many fine irregular pores; about 60 percent pebbles; NaF pH 10.5; moderately acid; clear wavy boundary.

2C-25 to 60 inches; olive brown (2.5Y 4/4) very gravelly loamy sand, pale yellow (2.5Y 7/4) and yellow (2.5Y 7/6) dry; single grain; loose; many fine irregular pores; about 60 percent pebbles; NaF pH 10.5; moderately acid.

The thickness of the solum and of the part of the profile influenced by volcanic ash is 14 to 30 inches. By weighted average, the upper part of the particle-size control section has 40 to 60 percent pebbles and 0 to 10 percent cobbles and the lower part has 45 to 75 percent pebbles and 0 to 10 percent cobbles.

The E horizon has hue of 5YR or 7.5YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist and dry.

The Bhs horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist and dry. It is very gravelly loam or very gravelly sandy loam.

The Bs and BC horizons have 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 and dry. They are very gravelly loam or very gravelly sandy loam.

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 and dry. It is very gravelly loamy sand, very gravelly sand, extremely gravelly loamy sand, or extremely gravelly sand.

### Kickerville Series

The Kickerville series consists of very deep, well drained soils formed in a mixture of loess and volcanic ash over glacial outwash. These soils are on outwash terraces. Slopes are 0 to 15 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy, mixed, mesic Typic Haplorthods.

Typical pedon of Kickerville silt loam, 0 to 3 percent slopes, 4 miles northeast of Lynden, 50 feet north and 700 feet east of the southwest corner of sec. 2, T. 40 N., R. 3 E.

Ap-0 to 9 inches; dark brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots; many very fine irregular pores; about 5 percent pebbles; NaF pH 11.5; moderately acid; abrupt smooth boundary.

Bs1-9 to 22 inches; dark yellowish brown (10YR 3/4) silt loam, light yellowish brown (10YR 6/4) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine roots; many very fine irregular pores; about 5 percent pebbles; NaF pH 12.0; moderately acid; abrupt smooth boundary.

2Bs2-22 to 32 inches; dark yellowish brown (10YR 4/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few very fine roots; many very fine irregular pores; about 40 percent pebbles and 5 percent cobbles; NaF pH 12.0; slightly acid; abrupt smooth boundary.

3C1-32 to 42 inches; extremely gravelly sand that is dominantly olive brown (2.5Y 4/4) and dark grayish brown (2.5Y 4/2) but is variegated; light yellowish brown (2.5Y 6/4) and light brownish gray (2.5Y 6/2) dry; single grain; loose; many very fine irregular pores; about 60 percent pebbles; NaF pH 12.0; slightly acid; clear smooth boundary.

3C2-42 to 60 inches; very gravelly sand that is dominantly dark grayish brown (2.5Y 4/2) but is variegated; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) dry; single grain; loose; many very fine irregular pores; about 50 percent pebbles; NaF pH 11.5; neutral.

The upper 14 to 24 inches of the soil is essentially nongravelly. Depth to the 2C horizon is 20 to 36 inches.

The content of rock fragments increases with increasing depth. It ranges from 0 to 10 percent pebbles in the upper part of the solum and from 35 to 65 percent pebbles and 0 to 5 percent cobbles in the lower part of the solum and substratum. By weighted average, the content of rock fragments in the particle-size control section is 25 to 35 percent.

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 or 3 when moist and dry.

The Bs1 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 and dry. It is loam or silt loam. The content of rock fragments ranges from 0 to 10 percent. The 2Bs2 horizon has value of 5 or 6 when dry and chroma of 3 or 4 when moist and dry. It is very gravelly loam, extremely gravelly loam, very gravelly silt loam, or very gravelly sandy loam.

The 3C horizon is variegated but has general hue of 10YR or 2.5Y, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist and dry. It is very gravelly loamy sand, extremely gravelly sand, or very gravelly sand.

### Kindy Series

The Kindy series consists of moderately deep, moderately well drained soils formed in a mixture of volcanic ash, loess, and colluvium over glacial till. These soils are on high mountain back slopes and plateaus. Slopes are 8 to 60 percent. The average annual precipitation is 70 to 90 inches, and the mean annual air temperature is about 43 degrees F.

These soils are loamy-skeletal, mixed, ortstein Typic Cryorthods.

Typical pedon of Kindy gravelly silt loam, 30 to 60 percent slopes, 5 miles southeast of Acme, 2,400 feet south and 1,900 feet east of the northwest corner of sec. 18, T. 37 N., R. 6 E.

Oi-6 inches to 1 inch; undecomposed needles, leaves, and twigs.

Oa-1 inch to 0; decomposed forest litter; many very fine, fine, and medium roots.

E-0 to 2 inches; brown (7.5YR 5/2) gravelly silt loam, pinkish gray (7.5YR 7/2) dry; massive; soft, friable, nonsticky and nonplastic; common very fine and many fine roots; many very fine irregular pores; about 30 percent pebbles; very strongly acid; abrupt smooth boundary.

Bhs-2 to 4 inches; strong brown (7.5YR 4/6) gravelly silt loam, strong brown (7.5YR 5/6) dry; dark brown (7.5YR 3/4) organic stains, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly

hard, firm, nonsticky and nonplastic; weakly smeary; common fine and few medium roots; many very fine irregular pores; about 30 percent pebbles; NaF pH 10.5; strongly acid; clear wavy boundary.

Bs-4 to 11 inches; brown (7.5YR 5/4) very gravelly silt loam, pink (7.5YR 7/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; about 40 percent pebbles; NaF pH 12.0; moderately acid; clear smooth boundary.

BC-11 to 25 inches; yellowish brown (10YR 5/6) very gravelly loam, very pale brown (10YR 7/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine irregular pores; about 50 percent pebbles; NaF pH 12.0; moderately acid; abrupt smooth boundary.

2Cd-25 to 60 inches; pale brown (10YR 6/3), dense glacial till that breaks to very gravelly loam, very pale brown (10YR 7/3) dry; massive; hard, firm, nonsticky and nonplastic; weakly smeary; about 40 percent pebbles; NaF pH 10.5; slightly acid.

The depth to dense, compact glacial till and the thickness of the part of the profile influenced by volcanic ash range from 20 to 40 inches. The content of rock fragments in the control section ranges from 35 to 60 percent.

The E horizon has hue of 7.5YR or 10YR and value of 4 to 6 when moist and 6 or 7 when dry.

The Bhs and Bs horizons have hue of 7.5YR or 10YR, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 4 to 6 when moist and dry. They are gravelly silt loam, gravelly loam, very gravelly silt loam, or very gravelly loam.

The 2Cd horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 3 to 6 when moist and dry. It is dense glacial till that breaks to very gravelly loam or very gravelly silt loam.

### Klawatti Series

The Klawatti series consists of moderately deep, well drained soils formed in volcanic ash, colluvium, and slope alluvium derived from dunite and serpentine. These soils are on high mountain shoulder slopes and ridgetops. Slopes are 30 to 60 percent. The average annual precipitation is 85 to 105 inches, and the mean annual air temperature is about 41 degrees F.

These soils are loamy-skeletal, serpentinitic Typic Cryorthods.

Typical pedon of Klawatti very gravelly loam, 30 to 60 percent slopes, 10 miles southeast of Van Zandt,

2,300 feet south and 400 feet west of the northeast corner of sec. 34, T. 38 N., R. 6 E.

Oi-7 to 5 inches; undecomposed needles, twigs, and bark.

Oa-5 inches to 0; decomposed organic mat; many very fine, fine, medium, and coarse roots; about 20 percent pebbles.

E-0 to 0.5 inch; dark gray (5YR 4/1) gravelly silt loam, light gray (5YR 7/1) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine irregular pores; about 25 percent pebbles; NaF pH 10.0; extremely acid; abrupt smooth boundary.

Bs1-0.5 inch to 2 inches; dark reddish brown (5YR 3/3) very gravelly loam, reddish brown (5YR 5/3) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many fine and common medium roots; many very fine irregular pores; about 30 percent pebbles and 10 percent cobbles; NaF pH 11.0; strongly acid; clear wavy boundary.

Bs2-2 to 10 inches; dark yellowish brown (10YR 4/4) extremely gravelly silt loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many fine and medium roots; many very fine irregular pores; about 45 percent pebbles and 20 percent cobbles; NaF pH 11.0; slightly acid; clear wavy boundary.

Bs3-10 to 25 inches; dark yellowish brown (10YR 3/4) extremely gravelly silt loam, light yellowish brown (10YR 6/4) dry; weak fine and medium subangular blocky structure; soft, friable, nonsticky and nonplastic; weakly smeary; common fine and many medium and coarse roots; many very fine irregular pores; about 40 percent pebbles, 20 percent cobbles, and 5 percent stones; NaF pH 11.0; slightly acid; abrupt wavy boundary.

2R-25 inches; dunite.

The depth to dunite or serpentine and the thickness of the part of the profile influenced by volcanic ash are 20 to 40 inches. The content of rock fragments in the control section ranges from 40 to 70 percent.

The E horizon has hue of 5YR or 7.5YR, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 1 or 2 when moist and dry.

The Bs1 horizon has hue of 2.5YR to 7.5YR, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist and dry. It is very gravelly loam, very gravelly silt loam, or extremely gravelly silt loam.

The Bs2 and Bs3 horizons have hue of 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 dry. They are very gravelly loam, very gravelly silt loam, or extremely gravelly silt loam.

### Kline Series

The Kline series consists of very deep, moderately well drained soils formed in alluvium. These soils are on alluvial fans. Slopes are 2 to 8 percent. The average annual precipitation is 40 to 70 inches, and the mean annual air temperature is about 50 degrees F.

These soils are sandy-skeletal, mixed, mesic Aquic Xerofluvents.

Typical pedon of Kline gravelly sandy loam, 2 to 8 percent slopes, 1.5 miles northwest of Deming, 1,300 feet north and 1,400 feet east of the southwest corner of sec. 25, T. 39 N., R. 4 E.

Ap-0 to 4 inches; dark brown (10YR 3/3) gravelly sandy loam, pale brown (10YR 6/3) dry; weak medium granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; about 30 percent pebbles; moderately acid; abrupt smooth boundary.

C1-4 to 9 inches; olive brown (2.5Y 4/4) gravelly sandy loam, light olive brown (2.5Y 5/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; about 20 percent pebbles; moderately acid; abrupt smooth boundary.

2C2-9 to 20 inches; dark brown (10YR 3/3) extremely gravelly loamy sand, brown (10YR 5/3) dry; single grain; loose; many very fine roots; many very fine irregular pores; about 70 percent pebbles; moderately acid; abrupt smooth boundary.

2C3-20 to 29 inches; dark grayish brown (2.5Y 4/2) very gravelly loamy sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; common very fine roots; many very fine irregular pores; about 60 percent pebbles; slightly acid; clear smooth boundary.

2C4-29 to 60 inches; dark grayish brown (2.5Y 4/2) very gravelly sand, light yellowish brown (2.5Y 6/3) dry; single grain; loose; very few very fine roots; many fine irregular pores; about 60 percent pebbles; strata of very gravelly sandy loam at 30 to 31 inches and at 47 to 48 inches; slightly acid.

The depth to the 2C horizon ranges from 8 to 20 inches. The content of rock fragments in the control section ranges from 45 to 75 percent.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist and dry.

The C1 horizon has hue of 10YR or 2.5Y and value

of 4 or 5 when moist and 5 or 6 when dry. It is gravelly or very gravelly loam or gravelly or very gravelly sandy loam. Some pedons have a weakly developed B horizon and do not have a C horizon.

The 2C horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist and dry. It is very gravelly sand, very gravelly loamy sand, or extremely gravelly loamy sand that has thin strata of sandy loam or very fine sandy loam. Some pedons have strata of sandy loam or very fine sandy loam below the control section. These strata are 10 to 30 inches thick.

### **Kulshan Series**

The Kulshan series consists of moderately deep, well drained soils formed in volcanic ash, loess, and colluvium and slope alluvium derived from sandstone and metasedimentary rocks. These soils are on mountain back slopes and ridges. Slopes are 5 to 80 percent. The average annual precipitation is 90 to 110 inches, and the mean annual air temperature is about 40 degrees F.

These soils are coarse-loamy, mixed Humic Cryorthods.

Typical pedon of Kulshan loam, 30 to 60 percent slopes, 7 miles southwest of Glacier, 1,500 feet south and 2,500 feet east of the northwest corner of sec. 33, T. 39 N., R. 6 E.

Oi-7 to 2 inches; undecomposed needles, twigs, bark, leaves, and moss.

Oa-2 inches to 0; decomposed needles, twigs, and leaves; many very fine, fine, medium, and coarse roots.

E-0 to 3 inches; dark brown (7.5YR 4/2) fine sandy loam, brown (7.5YR 5/2) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine, fine, medium, and coarse roots; common very fine irregular pores; about 5 percent pebbles; NaF pH 9.0; very strongly acid; abrupt smooth boundary.

Bhs1-3 to 8 inches; dark red (2.5YR 3/6) loam, yellowish red (5YR 5/6) dry; black (5YR 2/1) stains on 60 percent of soil matrix, dark reddish brown (5YR 3/3) dry; moderate medium subangular blocky structure; hard, firm, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium and few coarse roots; common very fine irregular pores; about 5 percent unweathered pebbles and 10 percent weathered pebbles; NaF pH 11.0; strongly acid; clear irregular boundary.

Bhs2-8 to 14 inches; yellowish red (5YR 4/6) gravelly loam, reddish yellow (7.5YR 6/6) dry; very dusky red (2.5YR 2/2) organic stains on faces of peds,

dark reddish brown (2.5YR 3/4) dry; moderate medium subangular blocky structure; hard, firm, nonsticky and nonplastic; weakly smeary; common very fine and fine roots; common very fine irregular pores; about 15 percent unweathered pebbles, 10 percent weathered pebbles, and 5 percent unweathered cobbles; NaF pH 12.0; strongly acid; clear wavy boundary.

Bs1-14 to 23 inches; yellowish red (5YR 5/6) cobbly fine sandy loam, reddish yellow (2.5YR 6/6) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine roots; common very fine irregular pores; about 10 percent unweathered cobbles, 25 percent weathered pebbles, and 10 percent unweathered cobbles; NaF pH 12.0; strongly acid; clear smooth boundary.

Bs2-23 to 30 inches; dark reddish brown (5YR 3/4) gravelly loam, reddish brown (5YR 4/4) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine roots; common very fine irregular pores; about 20 percent unweathered pebbles, 20 percent weathered pebbles, and 10 percent unweathered cobbles; NaF pH 12.0; strongly acid; abrupt smooth boundary.

2R-30 inches; hard sandstone.

The depth to sandstone and the thickness of the part of the profile influenced by volcanic ash are 20 to 40 inches. The content of rock fragments in the control section ranges from 5 to 25 percent unweathered pebbles, 15 to 35 percent weathered pebbles, and 0 to 10 percent unweathered cobbles.

The E horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 5 to 8 when dry, and chroma of 2 or 3 when moist and 1 or 2 when dry.

The Bhs horizon has hue of 2.5YR to 7.5YR, value of 3 or 4 when moist and 3 to 5 when dry, and chroma of 2 to 6 when moist and dry. It is loam, gravelly loam, or silt loam.

The Bs horizon has hue of 5YR to 10YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 2 to 6 when moist and dry. It is very gravelly loam, very gravelly fine sandy loam, or very gravelly sandy loam.

Some pedons have a C horizon.

### **Labounty Series**

The Labounty series consists of very deep, poorly drained soils formed in glaciomarine drift with an admixture of loess and volcanic ash. These soils are on glaciomarine drift plains and in depressional positions on the kame-kettle topography. Slopes are 0 to 2

percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are fine-loamy, mixed, mesic Typic Umbraqualfs.

Typical pedon of Labounty silt loam, in an area of Whatcom-Labounty silt loams, 0 to 8 percent slopes; 7 miles northeast of Bellingham, 20 feet north and 500 feet east of the southwest corner of sec. 30, T. 39 N., R. 4 E.

Ap-0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and nonplastic; many very fine and fine roots; many very fine irregular pores; about 5 percent pebbles; NaF pH 10.2; moderately acid; abrupt smooth boundary.

Eg1-10 to 13 inches; grayish brown (2.5Y 5/2) loam, white (2.5Y 8/2) dry; many coarse prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; about 5 percent pebbles; NaF pH 9.4; moderately acid; clear smooth boundary.

Eg2-13 to 16 inches; light brownish gray (2.5Y 6/2) loam, light gray (2.5Y 7/2) and white (2.5Y 8/2) dry; many coarse prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; about 5 percent pebbles; moderately acid; clear smooth boundary.

Eg3-16 to 22 inches; light olive gray (5Y 6/2) loam, white (5Y 8/2) dry; many coarse prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine irregular pores; about 10 percent pebbles; neutral; clear smooth boundary.

Btg1-22 to 28 inches; grayish brown (2.5Y 5/2) and olive gray (5Y 5/2) loam, light gray (2.5Y 7/2) and white (5Y 8/2) dry; many coarse prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6 and 6/8) dry; moderate thick platy structure; very hard, firm, slightly sticky and plastic; common very fine roots; common very fine irregular pores; few thin patchy clay films on faces of peds; about 5 percent pebbles; neutral; clear smooth boundary.

Btg2-28 to 35 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) loam, light gray (5Y 7/2) dry; many coarse prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; moderate thick platy structure; very hard, firm, slightly sticky and plastic; few very fine roots; few thin patchy clay films on faces of peds; common very fine irregular pores; about 5 percent pebbles; neutral; abrupt smooth boundary.

Cg-35 to 60 inches; gray (5Y 5/1) loam, light gray (5Y 6/1) dry; moderate medium blocky structure; extremely hard, very firm, slightly sticky and slightly plastic; very few very fine irregular pores; about 5 percent pebbles; neutral.

The thickness of the solum is 20 to 40 inches. By weighted average, the control section has 18 to 35 percent clay and 0 to 10 percent pebbles, although individual horizons contain 0 to 25 percent pebbles.

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 or 3 when moist and dry.

The Eg horizon has hue of 10YR or 2.5Y and value of 4 to 6 when moist and 6 to 8 when dry. It is loam or silt loam.

The Btg horizon has hue of 10YR to 5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 2 or 3 when moist and dry. It is loam, clay loam, or silty clay loam. It is weak or moderate and platy or subangular blocky, or it is massive.

The Cg 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 and dry. It is loam, clay loam, or silty clay loam.

### Larush Series

The Larush series consists of very deep, well drained soils formed in alluvium. These soils are on low river terraces. Slopes are 0 to 2 percent. The average annual precipitation is 60 to 70 inches, and the mean annual air temperature is about 49 degrees F.

These soils are coarse-silty over sandy or sandy-skeletal, mixed, mesic Fluventic Xerumbrepts.

Typical pedon of Larush silt loam, 0 to 2 percent slopes, 0.5 mile east of Acme, 500 feet south and 2,100 feet west of the northeast corner of sec. 8, T. 37 N., R. 5 E.

Ap-0 to 7 inches; very dark grayish brown (2.5Y 3/2) silt loam, grayish brown (2.5Y 5/2) dry; weak coarse granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and few fine roots;

many very fine irregular pores; slightly acid; clear smooth boundary.

C1-7 to 17 inches; very dark grayish brown (2.5Y 3.2) silt loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

C2-17 to 25 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

2C3-25 to 31 inches; dark grayish brown (2.5Y 4/2) stratified fine sand and sand, light brownish gray (2.5Y 6/2) dry; massive; soft, friable, nonsticky and nonplastic; thin strata of silt loam; very few very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

2C4-31 to 50 inches; dark grayish brown (2.5Y 4/2) fine sand, light brownish gray (2.5Y 6/2) dry; massive; loose, friable, nonsticky and nonplastic; thin strata of silt loam; very few very fine roots; many fine irregular pores; slightly acid; abrupt smooth boundary.

2C5-50 to 60 inches; dark grayish brown (2.5Y 4/2) sand, brownish gray (2.5Y 5/2) dry; single grain; loose; many fine irregular pores; slightly acid.

The thickness of the solum ranges from 15 to 30 inches. The solum has 5 to 10 percent clay and 0 to 15 percent sand coarser than very fine sand.

The A horizon has hue to 10YR or 2.5Y and value of 4 or 5 when dry. The C horizon has hue of 10YR or 2.5Y and value of 3 or 4 when moist and 5 or 6 when dry. It is silt loam or very fine sandy loam. Some pedons have a B horizon. The 2C horizon has value of 5 or 6 when dry. It is loamy fine sand, fine sand, or sand.

### **Laxton Series**

The Laxton series consists of very deep, moderately well drained soils formed in volcanic ash and loess over glacial outwash. These soils are on outwash terraces. Slopes are 0 to 15 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Haplorthods.

Typical pedon of Laxton loam, 0 to 3 percent slopes, 7 miles southeast of Blaine, 1,400 feet north and 400 feet east of the southwest corner of sec. 7, T. 40 N., R. 2 E.

Ap-0 to 9 inches; dark yellowish brown (10YR 3/4) loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine roots; many very fine irregular pores; NaF pH 10.5; slightly acid; clear smooth boundary.

Bs1-9 to 17 inches; dark brown (7.5YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and common fine roots; many very fine irregular pores; NaF pH 12.0; moderately acid; abrupt wavy boundary.

Bs2-17 to 23 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and common fine roots; many very fine irregular pores; NaF pH 12.0; moderately acid; abrupt wavy boundary.

2CB-23 to 32 inches; olive brown (2.5Y 4/4) loamy sand, pale yellow (2.5Y 7/4) dry; few fine prominent strong brown (7.5YR 4/6) mottles, reddish yellow (7.5YR 6/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and common fine roots; many very fine irregular pores; NaF pH 11.5; moderately acid; clear wavy boundary.

2C1-32 to 43 inches; sand that is dominantly olive brown (2.5Y 4/4) but is variegated; light yellowish brown (2.5Y 6/4) dry; common coarse prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; single grain; loose; common very fine roots; many very fine irregular pores; moderately acid; abrupt wavy boundary.

2C2-43 to 55 inches; sand that is dominantly light brownish gray (2.5Y 6/2) but is variegated; light gray (2.5Y 7/2) dry; common medium prominent dark yellowish brown (10YR 4/6) mottles, brownish yellow (10YR 6/6) dry; some dark yellowish brown (10YR 4/6) bands 1 to 2 millimeters thick; massive; soft, very friable, nonsticky and nonplastic; very few very fine roots; many very fine irregular pores; slightly acid; abrupt smooth boundary.

3C3-55 to 57 inches; dark yellowish brown (10YR 4/6) loamy sand, brownish yellow (10YR 6/6) dry; many fine distinct yellowish red (5YR 5/6) mottles, reddish yellow (5YR 6/6) dry; massive; slightly hard, very friable, nonsticky and nonplastic; very few very fine roots; many very fine irregular pores; slightly acid; abrupt smooth boundary.

4C4-57 to 60 inches; sand that is dominantly dark

grayish brown (2.5Y 4/2) but is variegated; light brownish gray (2.5Y 6/2) dry; single grain; loose; many very fine irregular pores; slightly acid.

The thickness of the solum and of the part of the profile influenced by volcanic ash is 20 to 40 inches. The lower part of the particle-size control section has 0 to 15 percent fine pebbles by weighted average. Mottles are below a depth of 20 inches. They are below a depth of 30 inches if chroma is 2 or less.

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 and dry.

The Bs horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 to 4 when moist and dry. It is silt loam, loam, or fine sandy loam.

The 2CB horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 3 or 4 when moist and dry. It has mottles with hue of 7.5YR or 10YR, value of 4 or 5 when moist, and chroma of 4 to 6 when moist and dry. It is loamy sand or loamy fine sand.

The 2C horizon is variegated but 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 dry. It has mottles with hue of 7.5YR or 10YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 2 to 6 when moist and dry. Either the matrix or the mottles have chroma of 2 or less in some part of the horizon. The 2C horizon is sand, fine sand, or loamy sand.

### Lynden Series

The Lynden series consists of very deep, well drained soils formed in volcanic ash and loess over glacial outwash. These soils are on outwash terraces. Slopes are 0 to 8 percent. The average annual precipitation is 40 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are sandy, mixed, mesic Typic Haplorthods.

Typical pedon of Lynden sandy loam, 3 to 8 percent slopes, 6 miles south of Lynden, 900 feet north and 750 feet east of the southwest corner of sec. 16, T. 39 N., R. 3 E.

Ap-0 to 8 inches; dark brown (7.5YR 3/2) sandy loam, dark brown (10YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots; many very fine irregular pores; NaF pH 11.0; moderately acid; abrupt smooth boundary.

Bs-8 to 18 inches; dark brown (7.5YR 4/4) sandy

loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots; many very fine irregular pores; NaF pH 12.0; slightly acid; abrupt smooth boundary.

2CBs-18 to 30 inches; very dark grayish brown (2.5Y 3/3) sand, pale brown (10YR 6/3) dry; single grain; loose; many very fine roots; many fine irregular pores; NaF pH 10.5; slightly acid; clear smooth boundary.

2C-30 to 60 inches; sand that is dominantly dark grayish brown (2.5Y 4/2) but is variegated; grayish brown (10YR 5/2) dry; single grain; loose; many fine irregular pores; slightly acid.

The thickness of the part of the profile influenced by volcanic ash and the depth to the 2CB horizon are 14 to 24 inches. The content of fine pebbles in the control section ranges from 0 to 15 percent.

The A horizon has hue of 7.5Y or 10YR and value of 3 or 4 when moist and 4 to 6 when dry. Some pedons have an E horizon.

The Bs horizon has hue of 7.5Y or 10YR and value of 4 or 5 when moist and 5 to 7 when dry.

The 2CBs horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist and dry. It is loamy sand, sand, or coarse sand.

The C horizon has hue of 10YR or 2.5Y. It is loamy sand, sand, or coarse sand.

### Lynnwood Series

The Lynnwood series consists of very deep, somewhat excessively drained soils formed in sandy glaciofluvial deposits mixed with loess and volcanic ash. These soils are on eskers and kames. Slopes are 0 to 20 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are sandy, mixed, mesic Typic Haplorthods.

Typical pedon of Lynnwood sandy loam, 0 to 5 percent slopes, 4.5 miles southeast of Blaine, 600 feet north and 1,700 feet east of the southwest corner of sec. 15, T. 40 N., R. 1 E.

A-0 to 3 inches; very dark brown (10YR 2/2) sandy loam, dark yellowish brown (10YR 4/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium roots; many fine irregular pores; NaF pH 10.0; strongly acid; abrupt wavy boundary.

Bs1-3 to 5 inches; dark brown (7.5YR 3/2 and 3/4) sandy loam, dark brown (7.5YR 4/4) and brown (7.5YR 5/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium roots; many fine irregular pores; NaF pH 12.0; strongly acid; clear wavy boundary.

Bs2-5 to 12 inches; dark yellowish brown (10YR 3/4 and 3/6) loamy sand, yellowish brown (10YR 5/4 and 5/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine, fine, and medium roots; many fine irregular pores; NaF pH 12.0; moderately acid; abrupt smooth boundary.

BC-12 to 19 inches; dark yellowish brown (10YR 3/6) loamy sand, light olive brown (2.5Y 5/4) dry; weak medium subangular blocky structure; loose, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; many fine irregular pores; NaF pH 12.0; moderately acid; clear smooth boundary.

C1-19 to 32 inches; sand variegated with hue of 2.5Y; single grain; loose; few fine roots; many fine irregular pores; NaF pH 12.0; moderately acid; gradual smooth boundary.

C2-32 to 60 inches; sand variegated with hue of 5Y; single grain; loose; many fine irregular pores; NaF pH 12.0; moderately acid.

The thickness of the solum is 15 to 36 inches. The content of rock fragments in the control section ranges from 0 to 10 percent.

The A horizon 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 4 when moist and dry.

The Bs 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 and dry. It is dominantly loamy fine sand or loamy sand. In some pedons, however, the upper 4 inches is sandy loam.

The C horizon has hue of 10YR to 5Y. It is sand, coarse sand, or gravelly sand. The content of rock fragments ranges from 0 to 15 percent.

### Montborne Series

The Montborne series consists of moderately deep, moderately well drained soils formed in an admixture of volcanic ash, loess, colluvium, and slope alluvium over glacial till derived dominantly from phyllite. These soils are on mountain back slopes and plateaus. Slopes are 5 to 60 percent. The average annual precipitation is 60 to 70 inches, and the mean annual air temperature is about 44 degrees F.

These soils are loamy-skeletal, mixed, frigid Typic Haplorthods.

Typical pedon of Montborne gravelly loam, 5 to 30 percent slopes, 3 miles southeast of Van Zandt, 800 feet south and 2,000 feet west of the northeast corner of sec. 27, T. 38 N., R. 5 E.

Oi-4 to 3 inches; undecomposed needles and twigs.

Oa-3 inches to 0; decomposed needles and twigs; many very fine, fine, medium, and coarse roots.

E-0 to 2 inches; dark brown (10YR 3/3) loam, light gray (10YR 7/2) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, medium, and coarse roots; many fine irregular pores; about 15 percent weathered pebbles and 5 percent hard pebbles; NaF pH 10.0; very strongly acid; abrupt wavy boundary.

Bs1-2 to 7 inches; dark yellowish brown (10YR 3/6) gravelly loam, yellowish brown (10YR 5/6) dry; moderate fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and coarse and many fine and medium roots; common very fine irregular pores; about 25 percent pebbles and 5 percent cobbles; NaF pH 11.5; strongly acid; clear wavy boundary.

Bs2-7 to 15 inches; dark yellowish brown (10YR 3/6) very gravelly loam, brownish yellow (10YR 6/6) dry; moderate fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; NaF pH 11.0; about 40 percent pebbles and 5 percent cobbles; common fine and medium and few coarse roots; common very fine irregular pores; strongly acid; clear smooth boundary.

CB-15 to 33 inches; olive brown (2.5Y 4/4) extremely gravelly sandy loam, pale yellow (2.5Y 7/4) dry; massive; soft, very friable, nonsticky and nonplastic; NaF pH 11.0; about 50 percent pebbles, 5 percent channers, and 5 percent cobbles; few fine and medium roots; common very fine irregular pores; moderately acid; abrupt smooth boundary.

2Cd-33 to 60 inches; light olive brown (2.5Y 5/4), dense glacial till that breaks to very gravelly loam, light gray (2.5Y 7/2) dry; massive; hard, firm, nonsticky and nonplastic; about 25 percent pebbles and 20 percent channers; moderately acid.

The thickness of the solum is 14 to 24 inches. The depth to dense, compact glacial till is 20 to 40 inches. The content of hard phyllite rock fragments in the control section ranges from 40 to 60 percent.

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 2

or 3 when moist and dry. Some pedons have an A horizon.

The Bs horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 4 to 6 when moist and dry. It is very gravelly loam or very gravelly silt loam.

The 2Cd 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 and dry. It is dense glacial till that breaks to very gravelly loam or very gravelly sandy loam.

### **Mt. Vernon Series**

The Mt. Vernon series consists of very deep, moderately well drained soils formed in alluvium with an admixture of volcanic ash in the upper part. These soils are on river terraces and flood plains. Slopes are 0 to 2 percent. The average annual precipitation is 30 to 50 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy, mixed, mesic Fluvaquent Haploxerolls.

Typical pedon of Mt. Vernon fine sandy loam, 0 to 2 percent slopes, 2 miles south of Ferndale, 750 feet north and 250 feet west of the southeast corner of sec. 31, T. 39 N., R. 2 E.

Ap1-0 to 7 inches; dark brown (10YR 3/3) fine sandy loam, grayish brown (2.5Y 5/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; moderately acid; clear smooth boundary.

Ap2-7 to 13 inches; very dark grayish brown (2.5Y 3/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; moderately acid; clear smooth boundary.

C1-13 to 20 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4), stratified fine sandy loam and sand, light brownish gray (2.5Y 6/2) and light olive brown (2.5Y 5/4) dry; many medium prominent yellowish brown (10YR 5/8) mottles, brownish yellow (10YR 6/8) dry; massive; soft, very friable, nonsticky and nonplastic; very few very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

C2-20 to 31 inches; olive gray (5Y 4/2), stratified fine sandy loam and sand, light brownish gray (2.5Y 6/2) and light gray (5Y 7/1) dry; common medium prominent yellowish brown (10YR 5/8) and strong brown (7.5YR 5/8) mottles, brownish yellow (10YR 6/8) dry; massive; soft, very friable, nonsticky and

nonplastic; many very fine irregular pores; slightly acid; clear smooth boundary.

C3-31 to 42 inches; olive gray (5Y 4/2), stratified very fine sandy loam and fine sandy loam, gray (5Y 6/1) dry; common medium prominent dark yellowish brown (10YR 4/6) mottles, brownish yellow (10YR 6/6) dry; massive; soft, very friable, nonsticky and nonplastic; many fine irregular pores; neutral when moist, slightly acid when dry; clear smooth boundary.

C4-42 to 60 inches; dark grayish brown (2.5Y 4/2) and dark gray (5Y 4/1), stratified sand and very fine sandy loam, light brownish gray (2.5Y 6/2) and gray (5Y 6/1) dry; common medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; soft, friable, nonsticky or slightly sticky and nonplastic; many fine irregular pores; neutral when moist, slightly acid when dry.

The control section contains, by weighted average, 5 to 18 percent clay and 15 to 30 percent sand coarser than very fine sand.

The Ap1 horizon has hue of 10YR or 2.5Y, value of 4 or 5 when dry, and chroma of 2 or 3 when moist and dry.

The Ap2 horizon has hue of 10YR or 2.5Y, value of 4 to 6 when dry, and chroma of 2 or 3 when moist and dry. It is fine sandy loam or very fine sandy loam.

The C 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 and dry. It is stratified very fine sandy loam, fine sandy loam, and sand. Reaction in the lower part of the C horizon is 0 to 0.5 pH unit lower when dry than when moist.

### **Nati Series**

The Nati series consists of moderately deep, well drained soils formed in colluvium and slope alluvium derived from sandstone and siltstone with an admixture of volcanic ash and glacial till. These soils are on foothill back slopes and plateaus. Slopes are 5 to 60 percent. The average annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 47 degrees F.

These soils are coarse-loamy, mixed, mesic Typic Haplorthods.

Typical pedon of Nati loam, 15 to 30 percent slopes, 6 miles southeast of Bellingham, 400 feet north and 2,000 feet east of the southwest corner of sec. 12, T. 37 N., R. 4 E.

O1-3.5 to 3 inches; undecomposed needles, leaves, and twigs.

O2-3 inches to 0; decomposed forest litter; many very fine and fine roots.

A-0 to 8 inches; dark brown (10YR 3/3) loam, yellowish brown (10YR 5/4) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; weakly smeary; common very fine and fine, many medium, and common coarse roots; many fine irregular pores; about 5 percent weathered pebbles; NaF pH 10.1; strongly acid; abrupt smooth boundary.

Bs-8 to 16 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium roots; many fine irregular pores; about 30 percent weathered pebbles and 5 percent hard, rounded pebbles; NaF pH 10.6; strongly acid; abrupt smooth boundary.

BC-16 to 31 inches; brownish yellow (10YR 6/6) fine sandy loam, pale yellow (2.5Y 7/4) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine, medium, and coarse roots; many fine irregular pores; about 35 percent weathered pebbles; NaF pH 11.0; strongly acid; abrupt wavy boundary.

2Cr-31 inches; sandstone.

The depth to sandstone and the thickness of the part of the profile influenced by volcanic ash are 20 to 40 inches. The content of hard rock fragments in the particle-size control section ranges from 5 to 20 percent and that of weathered fragments ranges from 20 to 50 percent.

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 6 when moist and 4 to 6 when dry.

The Bs 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 and dry. It is loam or sandy loam.

The BC horizon has hue of 7.5YR to 2.5Y, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 4 to 6 when dry. It is loam, sandy loam, fine sandy loam, or gravelly loam. Some pedons have a C horizon and do not have a BC horizon.

### Neptune Series

The Neptune series consists of very deep, somewhat excessively drained soils formed in coastal beach deposits that contain marine shells. These soils are on marine ridges, spits, and terraces. Slopes are 0 to 3 percent. The average annual precipitation is 30 to 40

inches, and the mean annual air temperature is 50 degrees F.

These soils are sandy-skeletal, mixed, mesic Entic Haploxerolls.

Typical pedon of Neptune very gravelly sandy loam, 0 to 3 percent slopes, 1.5 miles west of Blaine on Semiahmoo Spit, 3,200 feet east and 700 feet north of the southwest corner of sec. 2, T. 40 N., R. 1 W.

A-0 to 10 inches; black (10YR 2/1) very gravelly sandy loam, very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine, fine, medium, and coarse roots; many very fine irregular pores; 55 percent pebbles; slightly acid; clear smooth boundary.

AC-10 to 27 inches; very dark brown (10YR 2/2) extremely gravelly loamy sand, dark brown (10YR 3/3) dry; single grain; loose; many very fine and fine and common medium and coarse roots; common fine irregular pores; about 70 percent pebbles; about 10 percent marine shells; strongly effervescent; neutral; clear smooth boundary.

C1-27 to 45 inches; extremely gravelly coarse sand that is mostly dark gray (10YR 4/1) and gray (10YR 5/1) but is variegated black to white; single grain; loose; few fine and medium roots; many medium irregular pores; about 65 percent pebbles; about 25 percent marine shells; violently effervescent; mildly alkaline; clear smooth boundary.

C2-45 to 60 inches; extremely gravelly sand that is mostly dark gray (10YR 4/1) and gray (10YR 5/1) but is variegated black and white; single grain; loose; few very fine and fine roots; many medium irregular pores; about 60 percent pebbles and 5 percent cobbles; about 25 percent marine shells; violently effervescent; mildly alkaline.

The content of rock fragments in the particle-size control section ranges from 55 to 70 percent. The content of marine shell fragments ranges from 5 to 25 percent. The shell fragments are all less than 0.5 inch in size.

The A horizon has value of 2 or 3 when moist and 3 or 4 when dry and chroma of 1 or 2 when moist and 2 or 3 when dry. The AC horizon has value of 2 or 3 when moist and 3 or 4 when dry and chroma of 1 or 2 when moist and 1 to 3 when dry. It is very gravelly loamy sand, very gravelly sand, or extremely gravelly loamy sand. The C horizon is variegated with hues of 10YR or 2.5Y. It is extremely gravelly sand or extremely gravelly coarse sand.

## Oakes Series

The Oakes series consists of very deep, well drained soils formed in volcanic ash, colluvium, and slope alluvium derived from glacial drift. These soils are on colluvial mountain back slopes. Slopes are 5 to 80 percent. The mean annual precipitation is 65 to 85 inches, and the mean annual air temperature is about 44 degrees F.

These soils are loamy-skeletal, mixed, frigid Typic Haplorthods.

Typical pedon of Oakes very gravelly loam, 30 to 60 percent slopes, 1.5 miles northwest of Glacier, 500 feet north and 2,700 feet west of the southeast corner of sec. 36, T. 40 N., R. 6 E.

Oi-2 inches to 0; undecomposed needles, twigs, and leaves.

A-0 to 5 inches; dark brown (7.5YR 4/4) very gravelly loam, light brown (7.5YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; many very fine and fine and common medium roots; many fine irregular pores; about 40 percent pebbles and 15 percent cobbles; NaF pH 11.0; moderately acid; clear smooth boundary.

Bs1-5 to 17 inches; dark brown (7.5YR 4/4) very gravelly loam, pink (7.5YR 7/4) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; common very fine, many fine, and few medium roots; many fine irregular pores; about 50 percent pebbles and 10 percent cobbles; NaF pH 11.0; moderately acid; clear wavy boundary.

Bs2-17 to 29 inches; dark brown (7.5YR 4/4) extremely gravelly sandy loam, reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; many fine and medium and common coarse roots; many fine irregular pores; about 45 percent pebbles, 15 percent cobbles, and 5 percent stones; NaF pH 11.0; moderately acid; gradual wavy boundary.

C-29 to 60 inches; olive brown (2.5Y 4/4) extremely cobbly fine sandy loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; common fine, many medium, and common coarse roots; many fine irregular pores; about 40 percent pebbles, 25 percent cobbles, and 10 percent stones; NaF pH 10.5; moderately acid.

Volcanic ash influences the fine-earth fraction in the upper 24 to 60 inches. The depth to bedrock is more than 60 inches. The content of rock fragments in the

control section ranges from 35 to 70 percent. It includes 25 to 60 percent pebbles, 5 to 25 percent cobbles, and 0 to 10 percent stones. Less than 15 percent of the rock fragments are phyllite.

The A horizon has hue of 5YR to 10YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist and 2 to 6 when dry.

The Bs horizon has hue of 7.5YR to 10YR, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 2 to 6 when moist and dry. It is very gravelly loam or very gravelly sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist and 3 or 4 when dry. It is extremely gravelly loam, extremely gravelly fine sandy loam, extremely gravelly sandy loam, or extremely cobbly fine sandy loam.

## Oridia Series

The Oridia series consists of very deep, poorly drained soils formed in alluvium. These soils are on flood plains. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-silty, mixed, nonacid, mesic Aeric Fluvaquents.

Typical pedon of Oridia silt loam, drained, 0 to 2 percent slopes, 2.5 miles southwest of Lynden, 20 feet north and 2,620 feet east of the southwest corner of sec. 25, T. 40 N., R. 2 E.

Ap-0 to 10 inches; dark grayish brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

Cg1-10 to 17 inches; dark grayish brown (2.5Y 4/2) silt loam, light gray (2.5Y 7/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; slightly acid; clear smooth boundary.

Cg2-17 to 32 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam, light brownish gray (2.5Y 6/2) dry; common fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine irregular and few fine tubular pores; three strata of very fine sand 0.5 inch thick within the horizon; slightly acid; clear smooth boundary.

Cg3-32 to 60 inches; gray (5Y 5/1) and grayish brown (2.5Y 5/2) very fine sandy loam, light gray (5Y 7/1 and 2.5Y 7/2) dry; many medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine irregular and common fine tubular pores; slightly acid.

The particle-size control section contains, by weighted average, 8 to 18 percent clay and 0 to 15 percent fine sand or coarser textured material. These soils have an irregular distribution of organic matter with increasing depth.

The Ap horizon has hue of 10YR or 2.5Y and value of 3 or 4 when moist and 6 or 7 when dry. The Cg 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 and dry.

### Oso Series

The Oso series consists of moderately deep, well drained soils formed in volcanic ash, loess, glacial till, and colluvium derived from metasedimentary rocks (fig. 7). These soils are on ridges, plateaus, and high mountain back slopes. Slopes are 5 to 60 percent. The average annual precipitation is 70 to 90 inches, and the mean annual air temperature is about 42 degrees F.

These soils are coarse-loamy, mixed Typic Cryorthods.

Typical pedon of Oso silt loam, in an area of Kindy-Oso complex, 5 to 40 percent slopes; 2.5 miles

Oi-4 to 3 inches; undecomposed needles, twigs, cones, and dead moss.

Oa-3 inches to 0; decomposed organic mat; many very fine, fine, medium, and coarse roots.

E-0 to 1 inch; dark reddish gray (5YR 4/2) silt loam, pinkish gray (5YR 6/2) dry; massive; slightly hard, friable, nonsticky and slightly plastic; weakly smeary; many very fine and fine and common medium and coarse roots; common very fine irregular pores; about 5 percent rounded pebbles and 5 percent angular pebbles; NaF pH 10.0; strongly acid; abrupt smooth boundary.

Bs1-1 to 3 inches; dark reddish brown (5YR 3/3) silt loam, yellowish red (5TY 4/6) dry; moderate fine subangular blocky structure; slightly hard, firm, nonsticky and slightly plastic; weakly smeary; common very fine and fine and few medium roots;

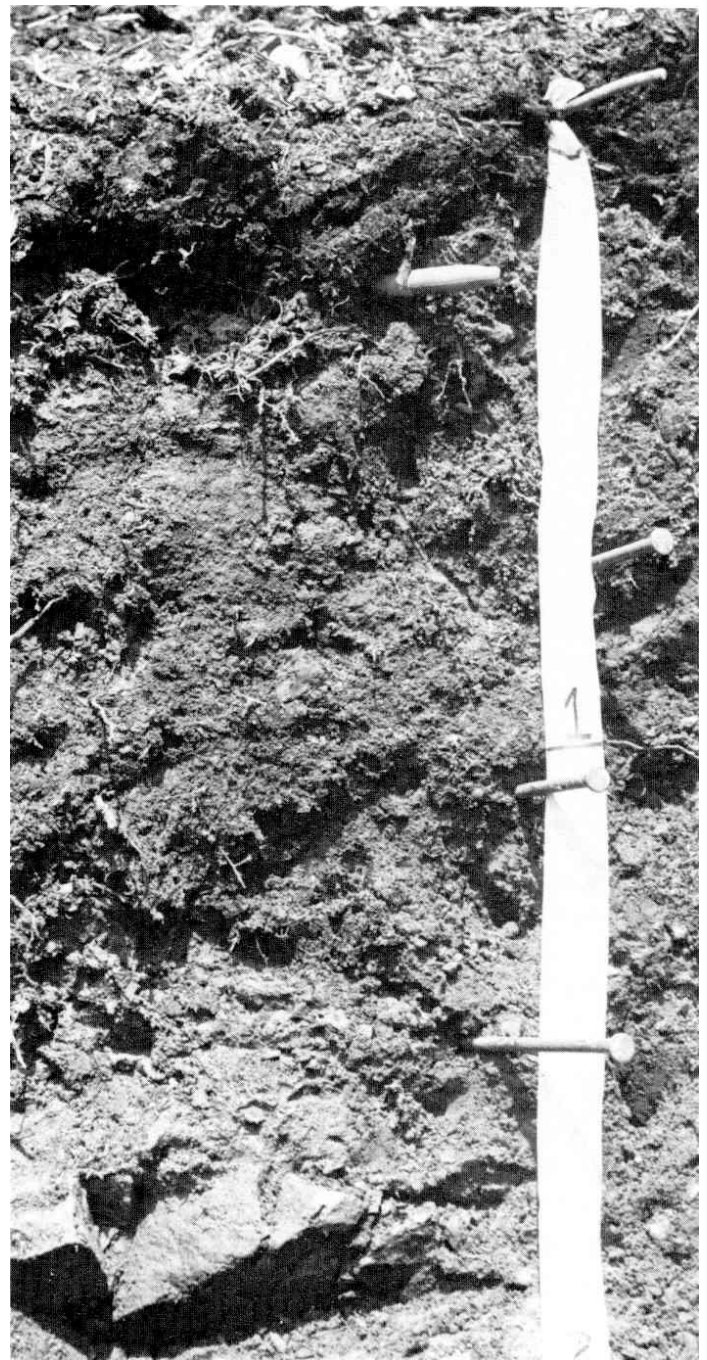


Figure 7.-Profile of Oso silt loam, in an area of the Kindy-Oso complex, 5 to 40 percent slopes. Bedrock is at a depth of 23 inches. Depth is marked in feet.

common very fine irregular pores; about 5 percent rounded pebbles and 5 percent angular pebbles; NaF pH 10.5; very strongly acid; clear smooth boundary.

Bs2-3 to 14 inches; dark brown (7.5YR 4/4) gravelly

silt loam, strong brown (7.5YR 5/6) dry; hard, firm, nonsticky and slightly plastic; weakly smeary; many very fine, fine, and medium and few coarse roots; common very fine irregular pores; about 5 percent rounded pebbles and 10 percent angular pebbles; NaF pH 10.5; strongly acid; clear smooth boundary.

BC-14 to 38 inches; dark yellowish brown (10YR 4/4) gravelly silt loam, light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine, fine, and medium roots; common very fine irregular pores; about 5 percent rounded pebbles and 25 percent angular pebbles; NaF pH 10.5; moderately acid; clear smooth boundary.

2R-38 inches; fractured metasedimentary rock.

The depth to lithic contact is 20 to 40 inches. The content of rock fragments in the control section ranges from 15 to 35 percent, although individual horizons contain as much as 50 percent pebbles.

Some pedons have an A horizon. This horizon has hue of 5YR or 7.5YR, value of 4 to 6 when moist and dry, and chroma of 2 to 4 when moist and dry.

The Bs 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 6 when moist and dry. It is silt loam, gravelly silt loam, or gravelly loam.

The BC horizon has hue of 7.5YR or 10YR, value of 5 to 7 when dry, and chroma of 4 to 6 when moist and dry. It is gravelly silt loam or gravelly loam. Some pedons have a C horizon.

### **Pangborn Series**

The Pangborn series consists of very deep, very poorly drained soils formed in herbaceous and woody organic deposits. These soils are in depressions on outwash terraces, till plains, and stream terraces. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are dysic, mesic Typic Medisaprists.

Typical pedon of Pangborn muck, drained, 0 to 2 percent slopes, 5 miles northeast of Lynden, 500 feet south and 2,500 feet west of the northeast corner of sec. 1, T. 40 N., R. 3 E.

Op-0 to 15 inches; dark reddish brown (5YR 3/2) muck, dark brown (7.5YR 3/2) dry; moderate medium granular structure; slightly hard, very friable, nonsticky and nonplastic; about 80 percent fiber, 5 percent rubbed; many very fine and fine roots; extremely acid; clear smooth boundary.

Oa1-15 to 29 inches; dark reddish brown (5YR 2/2)

muck, dark brown (7.5YR 3/2) dry; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; about 60 percent fiber, 5 percent rubbed; many very fine and fine roots; very strongly acid; clear smooth boundary.

Oa2-29 to 45 inches; dark reddish brown (5YR 2/2) muck, dark brown (7.5YR 3/2) dry; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; about 50 percent fiber, 5 percent rubbed; many very fine and fine roots; very strongly acid; clear smooth boundary.

Oa3-45 to 60 inches; very dark brown (7.5YR 2/2) muck, very dark grayish brown (10YR 3/2) dry; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; about 30 percent fiber, 2 percent rubbed; common very fine roots; very strongly acid.

Fibers are mostly from grasses and sedges, but pedons contain 0 to 15 percent wood fragments. The fiber content ranges from 30 to 80 percent when unrubbed and from 2 to 12 percent when rubbed. Thin, discontinuous layers of volcanic ash and diatomaceous earth (0.5 inch to 2 inches thick) are at a depth of 24 to 48 inches in some pedons.

The Oa horizon has hue of 5YR to 10YR, value of 2 to 4 when moist and 2 to 5 when dry, and chroma of 0 to 3 when moist and dry.

### **Pickett Series**

The Pickett series consists of moderately deep, well drained soils formed in colluvium derived from graywacke and argillite with an admixture of volcanic ash. These soils are on glacially modified back slopes and ridgetops. Slopes are 5 to 60 percent. The mean annual precipitation is 30 to 40 inches, and the mean annual air temperature is about 49 degrees F.

These soils are loamy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Pickett very gravelly silt loam, in an area of Pickett-Rock outcrop complex, 30 to 60 percent slopes; on Lummi Island, 3,500 feet north and 1,000 feet west of the southeast corner of sec. 23, T. 37 N., R. 1 E.

Oi-1.5 inches to 0; needles, leaves, and twigs.

A-0 to 2 inches; dark brown (7.5YR 3/3) gravelly silt loam, brown (7.5YR 5/4) dry; weak coarse granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine roots; many medium irregular pores; about 25 percent angular pebbles and 5 percent rounded

pebbles; NaF pH 10.0; slightly acid; clear smooth boundary.

- Bs1-2 to 15 inches; dark brown (7.5YR 4/4) very gravelly silt loam, reddish yellow (7.5YR 7/6) dry; weak coarse granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, and medium and common coarse roots; many medium irregular pores; about 40 percent angular pebbles and 5 percent rounded pebbles; NaF pH 10.5; slightly acid; clear smooth boundary.
- Bs2-15 to 29 inches; dark brown (7.5YR 4/4) very gravelly silt loam, reddish yellow (7.5YR 7/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine, many medium, and few coarse roots; many fine irregular pores; about 55 percent angular pebbles; NaF pH 11.0; moderately acid; abrupt smooth boundary.
- 2R-29 inches; fractured, hard graywacke.

The depth to bedrock and the thickness of the part of the profile influenced by volcanic ash are 20 to 40 inches. The content of rock fragments in the control section ranges from 35 to 55 percent angular pebbles, from 0 to 5 percent rounded pebbles, and from 0 to 10 percent angular cobbles.

The A horizon has value of 3 or 4 when moist and 4 to 7 when dry and chroma of 2 to 4 when moist and 4 to 6 when dry. In areas where it has value and chroma of 3 or less, it is less than 7 inches thick. The Bs horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 4 to 6 when dry.

### Pilchuck Series

The Pilchuck series consists of very deep, somewhat excessively drained soils formed in alluvium. These soils are on flood plains. Slopes are 0 to 3 percent. The average annual precipitation is 45 to 60 inches, and the mean annual air temperature is about 49 degrees F.

These soils are mixed, mesic Dystric Xeropsamments.

Typical pedon of Pilchuck loamy fine sand, 0 to 3 percent slopes, 1.5 miles northeast of Van Zandt, 1,000 feet north and 1,100 feet east of the southwest corner of sec. 33, T. 39 N., R. 5 E.

- Oi-2 inches to 0; undecomposed needles, leaves, and twigs.
- A-0 to 3 inches; black (10YR 2/1) fine sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; soft, very friable, nonsticky and

nonplastic; many very fine and common fine roots; many fine irregular pores; moderately acid; clear wavy boundary.

- C1-3 to 13 inches; very dark grayish brown (10YR 3/2) fine sand, dark grayish brown (10YR 4/2) dry; single grain; loose; few very fine and common fine, medium, and coarse roots; many fine irregular pores; moderately acid; clear smooth boundary.
- C2-13 to 25 inches; dark brown (10YR 3/3) loamy fine sand, brown (10YR 4/3) dry; single grain; loose; many fine, medium, and coarse roots; many fine irregular pores; moderately acid; clear smooth boundary.
- C3-25 to 44 inches; very dark brown (10YR 2/2) fine sand, dark gray (10YR 4/1) dry; single grain; loose; common fine, many medium, and few coarse roots; many medium irregular pores; moderately acid; abrupt smooth boundary.
- C4-44 to 60 inches; black (10YR 2/1) sand, very dark gray (10YR 3/1) dry; single grain; loose; many coarse irregular pores; slightly acid.

The content of rock fragments in the particle-size control section is 0 to 15 percent by weighted average.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 1 to 3 when moist and dry. Some pedons do not have an A horizon.

The C horizon has hue of 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 and dry. It is sand, fine sand, or loamy fine sand.

### Potchub Series

The Potchub series consists of moderately deep, moderately well drained soils formed in an admixture of volcanic ash, loess, and colluvium over glacial till. These soils are on high mountain back slopes and ridges. Slopes are 8 to 60 percent. The average annual precipitation is 70 to 100 inches, and the mean annual air temperature is about 42 degrees F.

These soils are coarse-loamy, mixed Humic Cryorthods.

Typical pedon of Potchub loam, 30 to 60 percent slopes, 2 miles south of Glacier, 600 feet north and 1,400 feet east of the southwest corner of sec. 17, T. 39 N., R. 7 E.

- Oi-8 to 2 inches; undecomposed needles, leaves, and twigs.
- Oa-2 inches to 0; decomposed forest litter; many very fine, fine, medium, and coarse roots.
- E-0 to 2 inches; dark brown (7.5YR 4/2) silt loam,

pinkish gray (7.5YR 6/2) dry; massive; hard, firm, slightly sticky and nonplastic; weakly smeary; common very fine and coarse and many fine and medium roots; common very fine irregular pores; about 10 percent weathered pebbles and 5 percent hard cobbles; NaF pH 10.0; strongly acid; abrupt smooth boundary.

Bhs-2 to 7 inches; strong brown (7.5YR 4/6) loam, strong brown (7.5YR 5/6) dry; dark reddish brown (5YR 3/3) organic stains, reddish brown (5YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine, many fine and medium, and few coarse roots; common very fine irregular pores; about 10 percent weathered pebbles and 5 percent hard cobbles; NaF pH 12.0; strongly acid; clear smooth boundary.

Bs1-7 to 11 inches; strong brown (7.5YR 5/6) gravelly loam, reddish yellow (7.5YR 6/6) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium roots; common very fine irregular pores; about 10 percent hard pebbles, 15 percent weathered pebbles, and 5 percent hard cobbles; NaF pH 12.0; strongly acid; clear wavy boundary.

Bs2-11 to 29 inches; strong brown (7.5YR 5/6) gravelly sandy loam, reddish yellow (7.5YR 7/6) dry; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine and fine roots; many fine irregular pores; about 15 percent hard pebbles, 20 percent soft pebbles, and 10 percent hard cobbles; NaF pH 11.5; strongly acid; clear wavy boundary.

Bs3-29 to 39 inches; brown (7.5YR 5/4) gravelly sandy loam, pink (7.5YR 7/4) dry; weak coarse subangular blocky structure; hard, firm, nonsticky and nonplastic; weakly smeary; few very fine, fine, and medium roots; common fine irregular pores; about 10 percent hard pebbles, 15 percent weathered pebbles, and 5 percent hard cobbles; NaF pH 11.5; strongly acid; abrupt smooth boundary.

2Cd-39 to 60 inches; light olive brown (2.5Y 5/4), dense glacial till that breaks to gravelly sandy loam, pale yellow (2.5Y 7/4) dry; massive; very hard, very firm, nonsticky and nonplastic; weakly smeary; about 15 percent hard pebbles and 20 percent weathered pebbles; moderately acid.

The depth to dense, compact glacial till is 20 to 40 inches. The part of the profile influenced by volcanic ash ranges from 30 to 60 inches. The control section contains 0 to 15 percent weathered rock fragments and 15 to 35 percent hard rock fragments. The total content

of rock fragments ranges from 15 to 35 percent.

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 or 2 when moist and dry.

The Bs horizon has hue of 5YR to 10YR, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 3 to 6 when moist and dry. It is gravelly loam or gravelly silt loam.

The 2Cd 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 and dry. It is dense glacial till that breaks to gravelly loam, gravelly sandy loam, very gravelly loam, or very gravelly sandy loam.

### **Puget Series**

The Puget series consists of very deep, poorly drained soils formed in alluvium on flood plains. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are fine-silty, mixed, nonacid, mesic Aeric Fluvaquents.

Typical pedon of Puget silt loam, drained, 0 to 2 percent slopes, 2 miles northeast of Everson, 2,000 feet north and 10 feet west of the southeast corner of sec. 19, T. 40 N., R. 4 E.

Ap-0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/2) dry; common fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; weak medium granular structure; slightly hard, friable, slightly sticky and plastic; many very fine and common fine roots; many very fine irregular pores; moderately acid; abrupt smooth boundary.

C1-9 to 16 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7.2) dry; many medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; hard, firm, slightly sticky and slightly plastic; many very fine roots; many very fine irregular and few fine tubular pores; moderately acid; clear smooth boundary.

C2-16 to 34 inches; gray (5Y 5/1) silt loam, light gray (5Y 7/1) dry; many large prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; hard, friable, slightly sticky and plastic; many very fine roots; many very fine irregular and common fine tubular pores; slightly acid; clear smooth boundary.

C3-34 to 60 inches; dark gray (5Y 4/1) silt loam, light gray (5Y 7/1) dry; many large prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; hard, friable, slightly sticky and

plastic; common very fine roots; many very fine irregular and common fine tubular pores; slightly acid.

The control section contains, by weighted average, 18 to 35 percent clay and 0 to 15 percent sand coarser than very fine sand. These soils have an irregular distribution of organic matter with increasing depth.

The A horizon has hue of 10YR or 2.5Y and value of 3 or 4 when moist and 6 or 7 when dry. 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 1 or 2 when moist and dry.

### **Puyallup Series**

The Puyallup series consists of very deep, well drained soils formed in alluvium. These soils are on flood plains and low river terraces. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 60 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy over sandy or sandy-skeletal, mixed, mesic Fluventic Haploxerolls.

Typical pedon of Puyallup fine sandy loam, 0 to 2 percent slopes, 0.25 mile southeast of Lynden, 1,800 feet south and 900 feet east of the northwest corner of sec. 21, T. 40 N., R. 3 E.

Ap-0 to 6 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak fine and medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; slightly acid; clear wavy boundary.

A1-6 to 12 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, slightly sticky and nonplastic; common very fine roots; many very fine irregular pores; neutral; clear smooth boundary.

A2-12 to 19 inches; very dark grayish brown (10YR 3/2) fine sandy loam, light brownish gray (10YR 6/2) and light gray (10YR 7/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; neutral; abrupt smooth boundary.

C1-19 to 27 inches; very dark grayish brown (10YR 3/2) sand, dark grayish brown (10YR 4/2) dry; single grain; loose; few very fine roots; many fine irregular pores; few pebbles; neutral; abrupt smooth boundary.

2C2-27 to 60 inches; very dark grayish brown (2.5Y 3/2) sand, dark grayish brown (2.5Y 4/2) dry; single grain; loose; many fine irregular pores; neutral.

The depth to the 2C horizon is 15 to 30 inches. The Moloch epipedon is 10 to 15 inches thick. The upper part of the particle-size control section has 5 to 15 percent clay, and the lower part has 0 to 5 percent clay.

The A horizon has hue of 10YR to 2.5Y, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 2 or 3 when moist and 3 or 4 when dry. In places the lower part of the A horizon has value of 6 or 7 when dry.

The 2C horizon has hue of 10YR or 2.5Y, value of 2 to 4 when moist and 4 or 5 when dry, and chroma of 1 to 4 when moist and dry. It is loamy sand, sand, or gravelly sand.

### **Revel Series**

The Revel series consists of moderately deep, well drained soils formed in a mixture of volcanic ash, colluvium, and slope alluvium derived dominantly from sandstone, siltstone, and glacial till. These soils are on mountain back slopes, ridges, and plateaus. Slopes are 5 to 60 percent. The average annual precipitation is 45 to 65 inches, and the mean annual air temperature is about 45 degrees F.

These soils are coarse-loamy, mixed, frigid Typic Haploorthods.

Typical pedon of Revel loam, 30 to 60 percent slopes, 6.5 miles south of Bellingham, 600 feet north and 100 feet west of the southeast corner of sec. 30, T. 37 N., R. 3 E.

Oi-1.5 inches to 0.5 inch; needles, leaves, and twigs. Oa-0.5 inch to 0; decomposed needles, leaves, and twigs; many very fine and common fine roots.

A-0 to 4 inches; dark brown (7.5YR 4/4) loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and few fine and medium roots; many fine irregular pores; about 5 percent hard rounded pebbles and 15 percent weathered angular pebbles; NaF pH 10.0; moderately acid; clear smooth boundary.

Bs-4 to 16 inches; dark brown (7.5YR 4/4) loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine and medium roots; many fine irregular pores; about 35 percent weathered angular pebbles; NaF pH 11.0; moderately acid; clear smooth boundary.

C-16 to 35 inches; dark yellowish brown (10YR 4/4) sandy loam, light yellowish brown (10YR 6/4) dry;

massive; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine and medium roots; many fine irregular pores; about 60 percent weathered angular pebbles and 10 percent soft angular cobbles; NaF pH 10.5; strongly acid; abrupt smooth boundary.

2Cr-35 inches; sandstone; few fine roots within rock fractures.

The depth to sandstone or siltstone and the thickness of the part of the profile influenced by volcanic ash are 20 to 40 inches. The content of rock fragments in the control section ranges from 35 to 65 percent weathered pebbles, from 0 to 15 percent weathered cobbles, and from 0 to 15 percent hard, rounded pebbles.

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 2 to 4 when moist and dry. Some pedons have an E horizon.

The Bs 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 and dry. It is loam or sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 3 or 4 when moist and dry. It is loam, sandy loam, or fine sandy loam.

### Rinker Series

The Rinker series consists of moderately deep, well drained soils formed in a mixture of volcanic ash, colluvium, and slope alluvium derived dominantly from phyllite. These soils are on mountain back slopes and shoulder slopes. Slopes are 8 to 60 percent. The average annual precipitation is 60 to 80 inches, and the mean annual air temperature is about 44 degrees F.

These soils, are loamy-skeletal, mixed, frigid Typic Haplorthods.

Typical pedon of Rinker very channery silt loam, 30 to 60 percent slopes, 5 miles southeast of Acme, 1,500 feet south and 2,200 feet west of the northeast corner of sec. 13, T. 37 N., R. 5 E.

Oi-4 to 3.5 inches; undecomposed needles, twigs, and leaves.

Oa-3.5 inches to 0; decomposed forest litter; many very fine, fine, medium, and coarse roots.

E-0 to 2 inches; brown (7.5YR 5/2) very channery silt loam, pinkish gray (7.5YR 7/2) dry; massive; soft, very friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; about 30 percent channers and 10 percent pebbles; extremely acid; abrupt wavy boundary.

Bs1-2 to 7 inches; dark brown (7.5YR 4/4 and 3/4) very channery silt loam, light brown (7.5YR 6/4) and strong brown (7.5YR 5/6) dry; moderate medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many fine and medium and common coarse roots; many very fine irregular pores; about 40 percent channers and 5 percent pebbles; NaF pH 9.4; very strongly acid; clear wavy boundary.

Bs2-7 to 11 inches; dark yellowish brown (10YR 4/4) extremely channery silt loam, very pale brown (10YR 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many fine and medium and common coarse roots; many very fine irregular pores; about 45 percent channers, 10 percent pebbles, and 10 percent cobbles; NaF pH 10.5; strongly acid; clear wavy boundary.

C-11 to 30 inches; olive brown (2.5Y 4/4) extremely channery loam, pale yellow (2.5Y 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many medium and coarse roots; many very fine irregular pores; about 60 percent channers and 10 percent cobbles; NaF pH 12.0; strongly acid; clear wavy boundary.

2R-30 inches; fractured phyllite.

The depth to phyllite and the thickness of the part of the profile influenced by volcanic ash are 20 to 40 inches. The content of rock fragments in the particle-size control section ranges from 50 to 70 percent.

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 and dry. Some pedons do not have an E horizon.

The Bs 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 and dry. It is very channery loam or very channery silt loam.

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 and dry. It is extremely channery loam, extremely channery silt loam, or very channery loam.

### Saar Series

The Saar series consists of moderately deep, moderately well drained soils formed in a mixture of volcanic ash and colluvium over glacial till. These soils are on mountain back slopes and shoulder slopes. Slopes are 5 to 60 percent. The average annual precipitation is 85 to 105 inches, and the mean annual air temperature is about 41 degrees F.

These soils are loamy-skeletal, mixed Humic Cryorthods.

Typical pedon of Saar gravelly silt loam, 5 to 30 percent slopes, 6 miles northwest of Glacier, 1,500 feet south and 1,200 feet west of the northeast corner of sec. 11, T. 40 N., R. 6 E.

Oi-7 to 6 inches; undecomposed needles, leaves, and twigs.

Oa-6 inches to 0; decomposed needles, leaves, and twigs; many very fine, fine, medium, and coarse roots.

E-0 to 4 inches; dark brown (7.5YR 4/2) gravelly silt loam, pinkish gray (7.5YR 6/2) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine and common medium and coarse roots; many very fine irregular pores; about 15 percent pebbles; NaF pH 10.0; very strongly acid; abrupt smooth boundary.

Bhs1-4 to 14 inches; dark brown (7.5YR 4/4) very gravelly silt loam, strong brown (7.5YR 5/6) dry; dark reddish brown (5YR 2/2) organic stains, dark reddish brown (5YR 3/2) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and common medium and coarse roots; many very fine irregular pores; about 40 percent pebbles; NaF pH 10.0; very strongly acid; clear smooth boundary.

Bhs2-14 to 22 inches; dark brown (10YR 3/3) very gravelly loam, yellowish brown (10YR 5/4) dry; dark reddish brown (5YR 2/2) organic stains, dark reddish brown (5YR 3/2) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine and common fine and medium roots; many very fine irregular pores; about 35 percent pebbles; NaF pH 11.5; strongly acid; clear smooth boundary.

BC-22 to 29 inches; dark brown (10YR 3/3) very gravelly loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few fine and medium roots; many very fine irregular pores; about 50 percent pebbles; NaF pH 11.0; strongly acid; abrupt smooth boundary.

2Cd-29 to 60 inches; gray (5Y 5/1), dense glacial till that breaks to extremely gravelly loam, gray (5Y 6/1) dry; massive; very hard, firm, nonsticky and nonplastic; about 70 percent pebbles; NaF pH 10.5; strongly acid.

The depth to dense glacial till is 20 to 40 inches. The thickness of the solum and of the part of the profile influenced by volcanic ash is 20 to 40 inches. The

content of rock fragments in the particle-size control section ranges from 35 to 60 percent.

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 2 or 3 when moist and 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 4 to 6 when moist and dry. It is very gravelly loam or very gravelly silt loam.

The BC horizon and the C horizon, if it occurs, have hue of 10YR or 2.5Y, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 2 to 4 when moist and dry. They are very gravelly loam or very gravelly silt loam.

The 2Cd horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 1 to 4 when moist and dry. It is dense glacial till that breaks to very gravelly loam, extremely gravelly loam, or extremely gravelly sandy loam.

### **Sandun Series**

The Sandun series consists of very deep, well drained soils formed in a mixture of loess and volcanic ash over glacial outwash derived from dunite. These soils are on outwash terraces, terrace escarpments, and mountain foot slopes. Slopes are 5 to 60 percent. The average annual precipitation is 70 to 90 inches, and the mean annual air temperature is about 43 degrees F.

These soils are sandy-skeletal, serpentinitic, frigid Typic Haploorthods.

Typical pedon of Sandun very gravelly sandy loam, 30 to 60 percent slopes, 6.5 miles east of Van Zandt, 1,900 feet north and 1,900 feet east of the southwest corner of sec. 20, T. 38 N., R. 6 E.

Oi-3 inches to 0; undecomposed leaves, needles, twigs, and wood fragments.

A-0 to 3 inches; dark reddish brown (5YR 3/4) gravelly sandy loam, brown (7.5YR 5/4) dry; moderate fine and medium granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few medium roots; common very fine irregular pores; about 30 percent pebbles; NaF pH 11.5; strongly acid; clear wavy boundary.

Bs1-3 to 11 inches; dark brown (7.5YR 3/4) very gravelly sandy loam, strong brown (7.5YR 5/6) dry; weak medium subangular blocky structure parting to weak medium granular; soft, very friable, nonsticky and nonplastic; weakly smeary; few very fine and common fine and medium roots; common very fine irregular pores; about 50 percent pebbles; NaF pH 12.0; moderately acid; abrupt irregular boundary.

Bs2-11 to 24 inches; dark brown (7.5YR 4/4) very gravelly sandy loam, strong brown (7.5YR 5/6) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine and few medium roots; common very fine irregular pores; about 50 percent pebbles; NaF pH 12.0; moderately acid; clear smooth boundary.

2BC-24 to 32 inches; dark yellowish brown (10YR 4/4) very gravelly loamy sand, brownish yellow (10YR 6/6) dry; massive; loose, nonsticky and nonplastic; weakly smeary; few very fine and fine roots; common very fine irregular pores; about 55 percent pebbles; NaF pH 12.0; moderately acid; abrupt smooth boundary.

2C1-32 to 36 inches; dark yellowish brown (10YR 4/4) very gravelly loamy sand; light yellowish brown (2.5Y 6/4) dry; massive; hard, firm, nonsticky and nonplastic; weakly smeary; very few very fine roots; many fine irregular pores; about 50 percent pebbles; NaF pH 12.0; moderately acid; abrupt smooth boundary.

2C2-36 to 60 inches; olive brown (2.5Y 4/4) very gravelly loamy sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose; very few very fine roots; many fine irregular pores; about 55 percent pebbles; NaF pH 12.0; slightly acid.

The content of rock fragments in the control section ranges from 40 to 80 percent. The rock fragments are dominantly dunite. The thickness of the solum and of the part of the profile influenced by volcanic ash ranges from 20 to 35 inches.

The A horizon has hue of 5YR to 10YR, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 or 4 when moist and dry.

The Bs horizon has hue of 5YR to 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 very gravelly sandy loam or very cobbly sandy loam.

The 2BC and 2C horizons have hue of 10YR or 2.5Y, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 3 to 6 when moist and dry. They are very gravelly loamy sand or very gravelly sand.

### Sehome Series

The Sehome series consists of moderately deep, moderately well drained soils formed in a mixture of volcanic ash and loess over glacial till. These soils are in glacially modified mountain foot slopes and in valleys. Slopes are 2 to 60 percent. The average annual precipitation is 40 to 60 inches, and the mean annual air temperature is about 49 degrees F.

These soils are coarse-loamy, mixed, mesic Typic Haplothods.

Typical pedon of Sehome loam, 2 to 8 percent slopes, 5.5 miles west of Wickersham, 1,300 feet north and 900 feet west of the southeast corner of sec. 32, T. 37 N., R. 4 E.

Oi-0.5 inch to 0; needles, leaves, twigs, and moss.

A-0 to 2 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine and fine roots; many fine irregular pores; about 5 percent pebbles; NaF pH less than 9.0; very strongly acid; abrupt smooth boundary.

Bs1-2 to 11 inches; dark brown (7.5YR 4/4) loam, light brown (7.5YR 6/4) dry; moderate fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few very fine, fine, and medium roots; common fine irregular pores; about 5 percent pebbles and 5 percent cobbles; NaF pH 12.0; strongly acid; clear smooth boundary.

Bs2-11 to 21 inches; dark yellowish brown (10YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; few very fine, fine, and medium roots; common fine irregular pores; about 20 percent pebbles and 5 percent cobbles; NaF pH 11.5; strongly acid; gradual smooth boundary.

Bs3-21 to 26 inches; dark yellowish brown (10YR 4/4) gravelly loam, very pale brown (10YR 7/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common fine and few medium roots; few very fine irregular pores; about 30 percent pebbles and 5 percent cobbles; strongly acid; abrupt smooth boundary.

2Cd-26 to 60 inches; grayish brown (2.5Y 5/2), dense glacial till that breaks to very gravelly loam, light gray (2.5Y 7/2) dry; few medium prominent brown (7.5YR 5/4) mottles, light brown (7.5YR 6/4) dry; massive; hard, firm, nonsticky and nonplastic; about 60 percent pebbles; NaF pH 10.0; moderately acid.

The depth to dense glacial till and the thickness of the solum and of the part of the profile influenced by volcanic ash are 24 to 40 inches. The content of rock fragments in the particle-size control section ranges from 15 to 35 percent. Individual horizons contain as much as 50 percent rock fragments in the lower part of the control section.

The A horizon has hue of 5YR to 10YR, value of 2 or

3 when moist and 3 to 5 when dry, and chroma of 2 to 4 when moist and dry. Some pedons have an E horizon.

The Bs 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 and dry. It is loam, gravelly loam, or gravelly silt loam.

Some pedons have a C horizon. The 2Cd horizon has value of 5 to 7 when moist and chroma of 2 to 4 when moist and 2 to 6 when dry. It is dense glacial till that crushes to very gravelly silt loam, very gravelly loam, or very gravelly sandy loam.

### Shalcar Series

The Shalcar series consists of very deep, very poorly drained soils formed in herbaceous and woody organic deposits over alluvium and glaciofluvial deposits. These soils are in depressions on outwash terraces, till plains, and stream terraces. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are loamy, mixed, euic, mesic Terric Medisapristis.

Typical pedon of Shalcar muck, drained, 0 to 2 percent slopes, 2 miles southeast of Everson, 1,300 feet north and 1,000 feet west of the southeast corner of sec. 5, T. 39 N., R. 4 E.

Oap-0 to 6 inches; black (10YR 2/1) muck, black (N 2/0) dry; moderate medium granular structure; slightly hard, very friable, nonsticky and nonplastic; about 15 percent fiber, 3 percent rubbed; many very fine roots; very strongly acid; abrupt irregular boundary.

Oa1-6 to 26 inches; black (10YR 2/1) muck, dark brown (7.5YR 3/2) dry; moderate medium granular structure; slightly hard, very friable, nonsticky and nonplastic; about 30 percent fiber, 5 percent rubbed; common very fine roots; very strongly acid; clear wavy boundary.

Oa2-26 to 37 inches; black (10YR 2/1) muck, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; slightly hard, very friable, nonsticky and nonplastic; about 20 percent fiber, 5 percent rubbed; common very fine roots; an intermittent layer of strong brown (7.5YR 4/6) fine sandy loam (volcanic ash), reddish yellow (7.5YR 6/6) dry; very strongly acid; abrupt smooth boundary.

2C1-37 to 52 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (2.5Y 5/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine irregular pores; about 5

percent pebbles; slightly acid; abrupt smooth boundary.

3C2-52 to 60 inches; dark gray (N 4/0) gravelly sand, gray (N 6/0) dry; single grain; loose; many fine irregular pores; about 15 percent pebbles; moderately acid.

The organic material is 16 to 51 inches thick. Fibers are mostly from grasses and sedges, but pedons contain as much as 10 percent wood fragments. The fiber content ranges from 5 to 40 percent when unrubbed, and from 2 to 15 percent when rubbed. The bottom tier is generally highest in fiber content. Thin, discontinuous layers of volcanic ash and diatomaceous earth (0.5 inch to 2 inches thick) are at a depth of 24 to 48 inches in some pedons.

The Oa horizon has hue of 5YR to 10YR or of N, value of 2 to 4 when moist and 2 to 5 when dry, and chroma of 0 to 3 when moist and dry.

The 2C1 horizon has hue of 10YR, 2.5Y, 5Y, or N, value of 3 to 5 when moist and 5 to 8 when dry, and chroma of 0 or 2 when moist and dry. It is silt loam, loam, or sandy loam.

Below a depth of 40 inches, the 3C horizon has hue of 5Y or N, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 0 or 1 when moist and dry. It has 0 to 60 percent pebbles. It is sand to clay loam in the fine-earth fraction. This horizon is below a depth of 60 inches in some pedons.

### Shuksan Series

The Shuksan series consists of moderately deep, moderately well drained soils formed in a mixture of volcanic ash, loess, and colluvium over glacial till. These soils are on mountain slopes and plateaus. Slopes are 5 to 80 percent. The average annual precipitation is 85 to 105 inches, and the mean annual air temperature is about 41 degrees F.

These soils are loamy-skeletal, mixed Humic Cryorthods.

Typical pedon of Shuksan gravelly silt loam, 5 to 30 percent slopes, 5 miles north of Glacier, 1,550 feet north and 100 feet east of the southwest corner of sec. 13, T. 40 N., R. 6 E.

Oi-9 to 7 inches; leaves, needles, twigs, and wood fragments.

Oa-7 inches to 0; decomposed forest litter; many very fine, fine, medium, and coarse roots.

E-0 to 2 inches; brown (7.5YR 5/2) fine sandy loam, pinkish gray (7.5YR 7/2) dry; moderate medium subangular blocky structure; hard, friable, nonsticky and nonplastic; many very fine, fine, medium, and

coarse roots; many fine irregular and few very fine tubular pores; about 10 percent pebbles; NaF pH 9.2; extremely acid; abrupt smooth boundary.

Bhs1-2 to 4 inches; dark reddish brown (5YR 3/2) silt loam, dark reddish gray (5YR 4/2) dry; black (5YR 2/1) organic stains throughout 80 percent of the soil matrix, dark reddish brown (5YR 3/2) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many fine and medium and common very fine and coarse roots; many fine irregular pores; about 5 percent pebbles; NaF pH 9.5; extremely acid; abrupt smooth boundary.

Bhs2-4 to 15 inches; strong brown (7.5YR 4/6) gravelly silt loam, strong brown (7.5YR 5/6) dry; dark reddish brown (5YR 3/2) organic stains throughout 50 percent of the soil matrix, dark reddish gray (5YR 4/2) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few very fine and common fine and medium roots; many very fine irregular and few fine tubular pores; about 25 percent pebbles and 5 percent cobbles; NaF pH 10.6; very strongly acid; abrupt smooth boundary.

Bs1-15 to 29 inches; dark brown (7.5YR 4/4) very gravelly loam, light brown (7.5YR 6/4) dry; dark reddish brown (5YR 3/2) organic stains throughout 40 percent of the soil matrix, dark reddish gray (5YR 4/2) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few fine roots; many fine irregular pores; about 40 percent pebbles and 5 percent cobbles; NaF pH 11.0; very strongly acid; clear smooth boundary.

Bs2-29 to 35 inches; dark yellowish brown (10YR 4/4) very gravelly loam, yellowish brown (10YR 5/4) dry; dark reddish brown (5YR 3/2) organic stains on faces of peds, dark reddish gray (5YR 4/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few fine irregular pores; about 40 percent pebbles; NaF pH 11.5; strongly acid; abrupt wavy boundary.

2Cd-35 to 60 inches; light olive brown (2.5Y 5/4), dense, compact glacial till that breaks to very gravelly sandy loam, pale yellow (2.5Y 7/4) dry; massive; hard, firm, nonsticky and nonplastic; about 40 percent pebbles; NaF pH 10.0; strongly acid.

The depth to compact glacial till is 20 to 40 inches. The content of rock fragments in the particle-size control section ranges from 35 to 50 percent.

The E horizon has hue of 5YR or 7.5YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist and dry.

The Bhs1 horizon has value of 2 to 4 when moist and 3 or 4 when dry and chroma of 2 or 3 when moist. The Bhs2 horizon has hue of 5YR or 7.5YR, value of 5 or 6 when dry, and chroma of 4 to 6 when moist and 6 to 8 when dry. It is gravelly loam or gravelly silt loam.

The Bs horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist and dry.

The 2Cd horizon has hue of 10YR to 5Y, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 to 4 when moist and dry. It is dense glacial till that breaks to very gravelly loam or very gravelly sandy loam.

### **Skipopa Series**

The Skipopa series consists of very deep, somewhat poorly drained soils formed in volcanic ash and loess over glaciolacustrine sediments. These soils are on terraces. Slopes are 0 to 8 percent. The average annual precipitation is 30 to 50 inches, and the mean annual air temperature is about 50 degrees F.

These soils are fine, mixed, mesic Aqualfic Haplorthods.

Typical pedon of Skipopa silt loam, 0 to 8 percent slopes, 1.5 miles north of Everson, 2,100 feet south and 100 feet east of the northwest corner of sec. 19, T. 40 N., R. 4 E.

Ap-0 to 8 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and common fine roots; many very fine irregular pores; NaF pH 10.5; moderately acid; clear smooth boundary.

Bs1-8 to 12 inches; dark brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine roots; many very fine irregular pores; NaF pH 10.5; moderately acid; clear smooth boundary.

Bs2-12 to 16 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) and very pale brown (10YR 7/4) dry; few fine prominent grayish brown (2.5Y 5/2) mottles, light gray (2.5Y 7/2) dry; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; weakly smeary; common very fine roots; many very fine irregular pores; NaF pH 10.0; moderately acid; clear smooth boundary.

BC-16 to 20 inches; brown (10YR 5/3) and grayish brown (2.5Y 5/2) silty clay loam, very pale brown (10YR 7/3) and light gray (2.5Y 7/2) dry; many fine

prominent olive brown (2.5Y 4/4) mottles, light olive brown (2.5Y 5/4) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; common very fine irregular pores; moderately acid; clear smooth boundary.

2C1-20 to 29 inches; dark brown (10YR 4/3) and brown (10YR 5/3) silty clay loam, brown (10YR 5/3) and very pale brown (10YR 7/3) dry; common fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; hard, firm, sticky and plastic; few very fine irregular pores; moderately acid; clear smooth boundary.

2C2-29 to 44 inches; brown (10YR 5/3) silty clay loam, pale brown (10YR 6/3) and very pale brown (10YR 7/3) dry; common fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; hard, firm, sticky and plastic; moderately acid; clear smooth boundary.

2C3-44 to 60 inches; light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) silty clay loam, light gray (2.5Y 7/2) and pale yellow (2.5Y 7/4) dry; few fine prominent dark reddish brown (5YR 2/2) mottles, dark reddish brown (5YR 3/2) dry; massive; extremely hard, extremely firm, sticky and plastic; neutral.

The thickness of the solum ranges from 14 to 24 inches. By weighted average, the content of rock fragments in the particle-size control section ranges from 0 to 10 percent. The content of clay ranges from 15 to 30 percent in the upper part of the control section and from 35 to 50 percent in the lower part.

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 and dry.

The Bs 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 and dry. It is silt loam or silty clay loam.

The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 when moist and 5 to 8 when dry, and chroma of 2 or 3 when moist and dry. It is silty clay loam, silty clay, or clay.

### **Skykomish Series**

The Skykomish series consists of very deep, somewhat excessively drained soils formed in glacial outwash and volcanic ash. These soils are on outwash terraces. Slopes are 3 to 30 percent. The average annual precipitation is 60 to 80 inches, and the mean annual air temperature is about 45 degrees F.

These soils are sandy-skeletal, mixed, frigid Typic Haplorthods.

Typical pedon of Skykomish very gravelly loam, 3 to 30 percent slopes, 1 mile south of Glacier, 1,100 feet south and 2,100 feet west of the northeast corner of sec. 12, T. 39 N., R. 6 E.

Oi-10 to 9 inches; undecomposed needles, leaves, wood, and twigs.

Oa-9 inches to 0; decomposed wood, needles, leaves, and twigs; many very fine, fine, medium, and coarse roots.

E-0 to 2 inches; brown (7.5YR 5/2) fine sandy loam, pinkish gray (7.5YR 7/2) dry; massive; soft, friable, slightly sticky and slightly plastic; weakly smeary; many fine and medium roots; many fine irregular pores; about 10 percent pebbles; extremely acid; clear wavy boundary.

Bs-2 to 14 inches; dark yellowish brown (10YR 4/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; many very fine, fine, medium, and coarse roots; many fine irregular pores; about 45 percent pebbles and 10 percent cobbles; strongly acid; clear wavy boundary.

2C1-14 to 30 inches; dark yellowish brown (10YR 4/4) extremely gravelly loamy sand, light yellowish brown (10YR 6/4) dry; single grain; loose; common fine and medium roots; many medium irregular pores; about 55 percent pebbles and 20 percent cobbles; strongly acid; gradual wavy boundary.

2C2-30 to 60 inches; brown (10YR 5/3) extremely gravelly sand, very pale brown (10YR 7/3) dry; single grain; loose; few fine roots; many medium irregular pores; about 45 percent pebbles, 10 percent cobbles, and 10 percent stones; strongly acid.

The thickness of the solum and of the part of the profile influenced by volcanic ash and the depth to the 2C horizon range from 14 to 20 inches. The content of rock fragments in the control section ranges from 35 to 55 percent in the solum and from 60 to 75 percent in the substratum.

The E horizon has value of 4 or 5 when moist and 6 or 7 when dry and chroma of 1 or 2 when dry.

The Bs horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist and dry. It is very gravelly loam or very gravelly sandy loam. Some pedons have a BC horizon.

The 2C horizon has value of 4 or 5 when moist and 6

or 7 when dry and chroma of 3 or 4 when moist and dry. It is extremely gravelly loamy sand or extremely gravelly sand.

### **Snohomish Series**

The Snohomish series consists of very deep, poorly drained soils formed in alluvium underlain by herbaceous and woody organic material. These soils are on flood plains. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

These soils are fine-silty, mixed, nonacid, mesic Thapto-Histic Fluvaquents.

Typical pedon of Snohomish silt loam, drained, 0 to 2 percent slopes, 2 miles west of Everson, 600 feet south and 600 feet west of the northeast corner of sec. 34, T. 40 N., R. 3 E.

Ap-0 to 6 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, firm, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; moderately acid; clear smooth boundary.

C-6 to 17 inches; dark grayish brown (2.5Y 4/2) silt loam, light gray (2.5Y 7/2) dry; few fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; slightly hard, firm, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; moderately acid; abrupt smooth boundary.

2Oa-17 to 40 inches; dark reddish brown (5YR 2/2) sapric material, dark reddish brown (5YR 3/2) dry; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; about 80 percent fiber, 10 percent rubbed; strongly acid; abrupt smooth boundary.

3C'-40 to 41 inches; strong brown (7.5YR 4/6) fine sandy loam (volcanic ash), yellow (10YR 7/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; weakly smeary; NaF pH 11.5; moderately acid; abrupt smooth boundary.

4Oa'-41 to 60 inches; dark reddish brown (5YR 2/2) sapric material, dark brown (7.5YR 3/2) dry; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; about 60 percent fiber, 10 percent rubbed; extremely acid.

The particle-size control section contains, by weighted average, 18 to 35 percent clay and 0 to 15 percent fine sand or coarser textured material in the mineral soil. These soils have an irregular distribution of

organic matter with increasing depth. Depth to the organic layer is 14 to 36 inches. Fibers are mostly from grasses and sedges, but pedons contain as much as 15 percent wood fragments. The fiber content ranges from 30 to 80 percent when unrubbed and from 2 to 12 percent when rubbed. Thin, discontinuous layers of volcanic ash and diatomaceous earth (0.5 inch to 2 inches thick) are at a depth of 24 to 48 inches in some pedons.

The Ap horizon has hue of 10YR or 2.5Y and value of 3 or 4 when moist and 6 or 7 when dry.

The C 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 and dry.

The 2Oa horizon has hue of 5YR to 10YR or of N, value of 2 to 4 when moist and 2 to 5 when dry, and chroma of 0 to 3 when moist and dry.

The 3C 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 and dry. It is fine sandy loam or loamy fine sand. It is absent or intermittent in some pedons.

### **Snoqualmie Series**

The Snoqualmie series consists of very deep, somewhat excessively drained soils formed in alluvium. These soils are on flood plains and low river terraces. Slopes are 0 to 3 percent. The average annual precipitation is 50 to 70 inches, and the mean annual air temperature is about 48 degrees F.

These soils are sandy-skeletal, mixed, mesic Dystric Xerorthents.

Typical pedon of Snoqualmie gravelly loamy sand, 0 to 3 percent slopes, 1.5 miles east of Maple Falls, 800 feet east and 2,100 feet north of the southwest corner of sec. 28, T. 40 N., R. 6 E.

Oi-1 inch to 0; undecomposed leaves and twigs; many very fine and fine roots.

A-0 to 4 inches; very dark grayish brown (2.5Y 3/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine irregular pores; about 10 percent pebbles; slightly acid; clear smooth boundary.

C1-4 to 14 inches; very dark gray (10YR 3/1) very gravelly coarse sand, gray (10YR 5/1) dry; single grain; loose; few fine and medium roots; many fine irregular pores; about 50 percent pebbles; neutral; clear wavy boundary.

C2-14 to 60 inches; very dark gray (10YR 3/1) and dark gray (10YR 4/1) very gravelly sand; single

grain; loose; many fine irregular pores; about 40 percent pebbles; neutral.

The depth to the C horizon is 4 to 14 inches. The content of rock fragments in the particle-size control section ranges from 35 to 60 percent.

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 or 2 when moist and dry.

The C horizon has hue of 10YR or 2.5Y, value of 2 to 4 when moist and 4 or 5 when dry, and chroma of 1 or 2 when moist and dry. It is very gravelly sand, extremely gravelly sand, or extremely gravelly loamy sand.

### **Sorensen Series**

The Sorensen series consists of very deep, well drained soils formed in a mixture of volcanic ash, loess, and colluvium derived from glacial till. The till was derived from phyllite. These soils are on mountain back slopes and toe slopes. Slopes are 8 to 60 percent. The average annual precipitation is 65 to 80 inches, and the mean annual air temperature is about 44 degrees F.

These soils are loamy-skeletal, mixed, frigid Typic Haplorthods.

Typical pedon of Sorensen very gravelly silt loam, 30 to 60 percent slopes, 4 miles southeast of Van Zandt, 2,000 feet south and 600 feet east of the northwest corner of sec. 26, T. 38 N., R. 5 E.

Oi-4 to 2 inches; undecomposed needles, leaves, and twigs.

Oa-2 inches to 0; decomposed needles, leaves, and twigs.

A-0 to 2 inches; dark brown (7.5YR 3/2) gravelly silt loam, yellowish brown (10YR 5/4) dry; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine roots; many very fine irregular pores; about 30 percent pebbles; NaF pH 10.0; strongly acid; abrupt smooth boundary.

Bs1-2 to 7 inches; dark brown (7.5YR 4/4) very gravelly silt loam, light yellowish brown (10YR 6/4) dry; moderate coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many very fine and common fine roots; many very fine irregular pores; about 30 percent pebbles and 10 percent cobbles; NaF pH 10.5; strongly acid; abrupt smooth boundary.

Bs2-7 to 13 inches; yellowish brown (10YR 5/4) very gravelly loam, pale yellow (2.5Y 7/4) dry; weak fine subangular blocky structure; soft, very friable,

slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; about 25 percent pebbles and 10 percent cobbles; NaF pH 12.0; strongly acid; clear wavy boundary.

BC-13 to 26 inches; light brownish gray (2.5Y 6/2) very gravelly loam, light gray (2.5Y 7/2) dry; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine and few fine and medium roots; many very fine irregular pores; about 30 percent pebbles and 10 percent cobbles; NaF pH 11.5; strongly acid; clear smooth boundary.

C-26 to 60 inches; light olive gray (5Y 6/2) very gravelly silt loam, light gray (5Y 7/1) dry; massive; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; many very fine irregular pores; about 35 percent pebbles; NaF pH 11.5; strongly acid.

The thickness of the solum is 18 to 30 inches. The thickness of the part of the profile influenced by volcanic ash is 30 to more than 60 inches. The content of rock fragments in the particle-size control section ranges from 35 to 60 percent pebbles and channers and from 0 to 15 percent cobbles. More than 15 percent of the rock fragments are phyllitic.

The A horizon has hue of 5YR to 10YR, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist and dry. Some pedons have an E horizon instead of an A horizon.

The Bs horizon has hue of 7.5YR to 2.5Y, value of 4 or 5 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist and dry. It is very gravelly loam or very gravelly silt loam.

The BC and C horizons have hue of 2.5Y or 5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 1 to 4 when moist and dry. They are very gravelly loam, very gravelly silt loam, or very gravelly sandy loam.

### **Springsteen Series**

The Springsteen series consists of moderately deep, well drained soils formed in a mixture of volcanic ash, colluvium, and glacial till derived from phyllite. These soils are on high mountain back slopes. Slopes are 30 to 60 percent. The average annual precipitation is 75 to 90 inches, and the mean annual air temperature is about 43 degrees F.

These soils are loamy-skeletal, mixed Typic Cryorthods.

Typical pedon of Springsteen very gravelly loam, 30

to 60 percent slopes, 6.5 miles east of Acme, 2,300 feet south and 1,600 feet east of the northwest corner of sec. 17, T. 37 N., R. 6 E.

Oa-5 to 4 inches; undecomposed needles, leaves, and twigs.

Oi-4 inches to 0; decomposed needles, leaves, and twigs; many very fine, fine, and medium and common coarse roots.

E-0 to 5 inches; brown (7.5YR 5/2) very gravelly loam, pinkish gray (7.5YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; about 35 percent pebbles; extremely acid; abrupt smooth boundary.

Bs-5 to 13 inches; dark yellowish brown (10YR 4/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine roots; many very fine irregular pores; about 40 percent pebbles and 10 percent cobbles; NaF pH 11.0; very strongly acid; clear smooth boundary.

C-13 to 24 inches; dark brown (10YR 4/3) very gravelly loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many fine and medium roots; many very fine irregular pores; about 30 percent pebbles and 10 percent cobbles; NaF pH 9.6; very strongly acid; clear smooth boundary.

2R-24 inches; phyllite; few fine roots in rock fractures.

The depth to fractured phyllite is 20 to 40 inches. The control section contains 35 to 60 percent hard rock fragments and 0 to 25 percent soft rock fragments.

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 and dry.

The Bs horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist and dry. It is very gravelly loam or very gravelly silt loam.

The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist and dry. It is very gravelly loam or very cobbly loam.

### **Squalicum Series**

The Squalicum series consists of deep, moderately well drained soils formed in a mixture of volcanic ash, loess, and slope alluvium over glacial till. These soils are on foothills and in valleys. Slopes are 5 to 60

percent. The average annual precipitation is 40 to 55 inches, and the mean annual air temperature is about 48 degrees F.

These soils are coarse-loamy, mixed, mesic Typic Haplorthods.

Typical pedon of Squalicum gravelly loam, 5 to 15 percent slopes, 7 miles south of Bellingham, 600 feet north and 2,250 feet east of the southwest corner of sec. 28, T. 37 N., R. 3 E.

Oi-1 inch to 0; undecomposed needles, leaves, and twigs.

A-0 to 3 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 5/3) dry; weak coarse granular structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; many very fine and few fine roots; about 10 percent hard pebbles and 10 percent weathered pebbles; NaF pH 10.5; moderately acid; abrupt smooth boundary.

Bs1-3 to 17 inches; dark yellowish brown (10YR 4/6) gravelly loam, yellow (10YR 7/6) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; common very fine, fine, and coarse roots; about 20 percent hard pebbles and 5 percent weathered pebbles; NaF pH 11.5; moderately acid; clear wavy boundary.

Bs2-17 to 30 inches; dark yellowish brown (10YR 3/6) gravelly loam, yellow (10YR 7/6) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine, medium, and coarse roots; about 25 percent hard pebbles and 10 percent weathered pebbles; NaF pH 12.0; moderately acid; clear wavy boundary.

C-30 to 44 inches; light olive brown (2.5Y 5/4) gravelly loam, pale yellow (2.5Y 7/4) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine and few medium and coarse roots; about 30 percent hard pebbles and 15 percent weathered pebbles; NaF pH 12.0; moderately acid; abrupt smooth boundary.

2Cd-44 to 60 inches; olive gray (5Y 5/2), dense glacial till that breaks to gravelly loam, light gray (5Y 7/2) dry; massive; very hard, firm, nonsticky and nonplastic; about 30 percent hard pebbles and 5 percent weathered pebbles; NaF pH 10.0; moderately acid.

The depth to dense, compact glacial till and the thickness of the part of the profile influenced by volcanic ash range from 40 to 60 inches. The thickness of the solum is 17 to 35 inches. The content of rock fragments in the particle-size control section ranges from 20 to 35 percent, although individual horizons

contain as much as 50 percent hard coarse fragments.

The control section also includes 0 to 15 percent weathered coarse fragments by weighted average.

The A horizon has hue of 7.5YR or 10YR and chroma of 2 to 4 when moist and 3 or 4 when dry.

The Bs 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 to 6 when moist and dry. It is loam, gravelly loam, or gravelly fine sandy loam.

The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 3 or 4 when moist and dry. It is gravelly loam, gravelly fine sandy loam, gravelly sandy loam, or very gravelly sandy loam.

The 2Cd 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 and dry. It is dense glacial till that breaks to gravelly loam, gravelly sandy loam, very gravelly loam, or very gravelly sandy loam.

### **Squires Series**

The Squires series consists of moderately deep, well drained soils formed in a mixture of volcanic ash, loess, glacial till, and colluvium derived dominantly from phyllite. These soils are on low mountain back slopes, toe slopes, and foothills. Slopes are 5 to 60 percent. The average annual precipitation is 45 to 60 inches, and the mean annual air temperature is about 48 degrees F.

These soils are loamy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Squires very channery silt loam, 5 to 30 percent slopes, 4.5 miles east of Acme, 100 feet south and 2,500 feet west of the northeast corner of sec. 12, T. 37 N., R. 5 E.

Oi-6 inches to 0; undecomposed needles, leaves, and twigs; many very fine, fine, medium, and coarse roots.

E-0 to 2 inches; brown (7.5YR 5/2) channery silt loam, pinkish gray (7.5YR 7/2) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine irregular pores; about 25 percent pebbles and 5 percent cobbles; extremely acid; abrupt wavy boundary.

Bs1-2 to 5 inches; dark brown (7.5YR 3/4) very channery silt loam, strong brown (7.5YR 5/6) dry; dark brown (7.5YR 3/2) organic stains, dark brown (7.5YR 4/4) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, and

medium roots; many very fine irregular pores; about 25 percent channers and 10 percent cobbles; NaF pH 12.0; moderately acid; clear wavy boundary.

Bs2-5 to 12 inches; dark brown (7.5YR 4/4) very channery loam, strong brown (7.5YR 5/6) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine and common fine and medium roots; many very fine irregular pores; about 35 percent channers and 15 percent cobbles; NaF pH 12.0; moderately acid; clear wavy boundary.

BC-12 to 18 inches; dark yellowish brown (10YR 4/4) very channery loam, light yellowish brown (10YR 6/4) dry; massive; soft, friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium roots; many very fine irregular pores; about 30 percent channers and 15 percent cobbles; NaF pH 12.0; moderately acid; clear wavy boundary.

C-18 to 30 inches; light olive brown (2.5Y 5/4) very channery sandy loam, pale yellow (2.5Y 7/4) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine and medium roots; many very fine irregular pores; about 40 percent channers and 20 percent cobbles; NaF pH 12.0; moderately acid; abrupt wavy boundary.

2R-30 inches; fractured phyllite.

The depth to phyllite and the thickness of the part of the profile influenced by volcanic ash are 20 to 40 inches. The content of rock fragments in the control section ranges from 35 to 60 percent.

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 2 to 4 when moist and dry. Some pedons have an A horizon instead of an E horizon.

The Bs horizon has hue of 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 dry. It is very channery loam, very gravelly loam, or very gravelly silt loam.

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 dry. It is very channery loam, very gravelly loam, very channery silt loam, very gravelly silt loam, very channery sandy loam, or very gravelly sandy loam.

### **Sumas Series**

The Sumas series consists of very deep, poorly drained soils formed in recent alluvium. These soils are on flood plains. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 60 inches, and the mean

annual air temperature is about 50 degrees F.

These soils are fine-silty over sandy or sandy-skeletal, mixed, nonacid, mesic Aeric Fluvaquents.

Typical pedon of Sumas silt loam, drained, 0 to 2 percent slopes, 2 miles southwest of Sumas, 2,000 feet south and 100 feet west of the northeast corner of sec. 9, T. 40 N., R. 4 E.

Ap-0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/2) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; common very fine and few fine roots; many fine irregular and common fine tubular pores; moderately acid; clear smooth boundary.

Cg1-8 to 26 inches; grayish brown (2.5Y 5/2) silt loam, light gray (10YR 7/1) dry; common medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; hard, firm, sticky and plastic; common very fine roots; many fine irregular pores and many fine and common medium tubular pores; slightly acid; abrupt wavy boundary.

2Cg2-26 to 60 inches; very dark grayish brown (2.5Y 3/2) sand, grayish brown (2.5Y 5/2) dry; few medium prominent dark brown (7.5YR 3/4) mottles, strong brown (7.5YR 5/6) dry; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; many medium irregular pores; slightly acid.

The depth to sand or gravelly sand, ranges from 14 to 36 inches. The upper part of the particle-size control section has 18 to 35 percent clay and 0 to 15 percent fine sand or coarser textured material. The content of rock fragments in the lower part of the control section ranges from 0 to 10 percent.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4 when moist and 4 to 7 when dry, and chroma of 1 to 3 when moist and dry. It is mottled in some pedons.

The Cg1 horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 6 when moist and 4 to 8 when dry, and chroma of 1 or 2 when moist and dry. It is silt loam or silty clay loam.

The 2Cg2 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 or 2 when moist and dry. It is loamy fine sand, loamy sand, sand, or gravelly sand.

### **Tacoma Series**

The Tacoma series consists of very deep, very poorly drained soils formed in recent alluvium. These soils are on flood plains, deltas, and tidal flats. Slopes are 0 to 1 percent. The average annual precipitation is 30 to 40

inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-silty, mixed, acid, mesic Sulfic Fluvaquents.

Typical pedon of Tacoma silt loam, drained, 0 to 1 percent slopes, 3.5 miles southwest of Ferndale, 200 feet south and 100 feet east of the northwest corner of sec. 7, T. 38 N., R. 2 E.

Ap-0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/2) dry; common fine prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; very hard, firm, slightly sticky and plastic; common very fine and fine roots; many very fine irregular pores; very strongly acid; clear wavy boundary.

C1-7 to 12 inches; dark grayish brown (2.5Y 4/2) silt loam, gray (5Y 6/1) dry; many medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; very hard, friable, slightly sticky and plastic; common very fine and fine roots; common very fine irregular pores; very strongly acid; clear smooth boundary.

C2-12 to 17 inches; dark gray (5Y 4/1) silt loam, light gray (5Y 7/1) dry; many medium prominent strong brown (7.5YR 5/6) mottles, yellowish brown (10YR 5/6) dry; massive; very hard, friable, sticky and plastic; few very fine roots; common very fine irregular pores; very strongly acid when moist, extremely acid when dry; clear smooth boundary.

C3-17 to 26 inches; dark gray (5Y 4/1) silt loam, light gray (5Y 7/1) dry; many medium prominent strong brown (7.5YR 5/6) and dark yellowish brown (10YR 4/6) mottles, strong brown (7.5YR 5/6) and olive brown (2.5Y 6/6) dry; massive; very hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine irregular pores; very strongly acid when moist, extremely acid when dry; clear smooth boundary.

C4-26 to 37 inches; dark gray (5Y 4/1) silt loam, light gray (5Y 7/1) dry; common medium prominent olive brown (2.5Y 4/4) mottles, light olive brown (2.5Y 5/6) dry; massive; hard, friable, slightly sticky and slightly plastic; common very fine irregular pores; very strongly acid when moist, extremely acid when dry; abrupt smooth boundary.

C5-37 to 60 inches; dark gray (5Y 4/1) very fine sandy loam, gray (5Y 6/1) dry; many coarse prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/8) dry; massive; hard, friable, slightly sticky and slightly plastic; few very fine irregular pores; very strongly acid.

The particle-size control section has, by weighted

average, 10 to 18 percent clay and 0 to 15 percent sand coarser than very fine sand. Reaction is very strongly acid or strongly acid when moist and extremely acid or very strongly acid when dry.

The A horizon has hue of 10YR or 2.5Y and value of 6 or 7 when dry. Structure is granular or massive.

The C horizon has hue of 2.5Y, 5Y, or N, value of 6 or 7 when dry, and chroma of 0 to 2 when moist and dry. It is dominantly silt loam or very fine sandy loam. In some pedons, however, it has strata of sand or fine sandy loam below a depth of 40 inches.

### **Tromp Series**

The Tromp series consists of very deep, moderately well drained soils that formed in a mixture of volcanic ash and loess over glacial outwash. These soils are on outwash terraces. Slopes are 0 to 2 percent. The average annual precipitation is 40 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are sandy, mixed, mesic Aquic Haploorthods.

Typical pedon of Tromp loam, 0 to 2 percent slopes, 2 miles north of Ferndale, 2,300 feet south and 2,400 feet east of the northwest corner of sec. 8, T. 39 N., R. 2 E.

Ap-0 to 11 inches; dark brown (10YR 3/3) loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine roots; many very fine irregular pores; NaF pH 12.0; moderately acid; abrupt smooth boundary.

Bs1-11 to 15 inches; dark brown (7.5YR 4/4) loam, brownish yellow (10YR 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; NaF pH 12.0; strongly acid; clear smooth boundary.

Bs2-15 to 20 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 nonplastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; NaF pH 12.0; strongly acid; abrupt smooth boundary.

BCs-20 to 26 inches; dark yellowish brown (10YR 4/4) sandy loam, light yellowish brown (10YR 6/4) dry; many fine prominent strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry; massive; slightly hard, friable, nonsticky and nonplastic;

common very fine and fine roots; common fine irregular pores; NaF pH 11.5; moderately acid; abrupt smooth boundary.

2CBs-26 to 46 inches; olive brown (2.5Y 4/4), weakly cemented sand, pale yellow (2.5Y 7/4) dry; common medium prominent yellowish brown (10YR 5/6) and dark grayish brown (2.5Y 4/2) mottles, brownish yellow (10YR 6/6) and light gray (2.5Y 7/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; many fine irregular pores; NaF pH 12.0; moderately acid; clear irregular boundary.

2C-46 to 60 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) sand, light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) dry; common medium prominent yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; single grain; loose; NaF pH 11.0; moderately acid.

The thickness of the part of the profile influenced by volcanic ash and the thickness of the solum are 14 to 30 inches. The content of rock fragments in the control section ranges from 0 to 5 percent pebbles.

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 and dry.

The Bs horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 3 to 6 when moist and dry. It is silt loam, loam, or sandy loam.

The BCs and 2CBs horizons have hue of 10YR or 2.5Y, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 2 to 4 when moist and dry. The 2CB horizon is weakly cemented and has slightly hard or hard consistence when dry. It is massive or contains 1 to 15 percent ortstein fragments 0.25 inch to 2 inches in diameter.

The 2C horizon has hue of 10YR to 5Y, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist and dry. It is loamy sand or sand.

### **Twinsi Series**

The Twinsi series consists of moderately deep, moderately well drained soils formed in colluvium and glacial till derived from dunite with an admixture of volcanic ash and loess. These soils are on high mountain back slopes and shoulder slopes. Slopes are 30 to 60 percent. The average annual precipitation is 90 to 105 inches, and the mean annual air temperature is about 41 degrees F.

These soils are loamy-skeletal, serpentinitic Typic Cryorthods.

Typical pedon of Twinsi very gravelly loam, 30 to 60

percent slopes, 9 miles southeast of Van Zandt, 2,400 feet north and 700 feet east of the southwest corner of sec. 3, T. 37 N., R. 6 E.

Oi-8 to 2 inches; undecomposed needles, twigs, and bark.

Oa-2 inches to 0; decomposed organic mat; many very fine, fine, medium, and common coarse roots.

E-0 to 1 inch; brown (7.5YR 5/2) gravelly fine sandy loam, pinkish gray (7.5YR 7/2) dry; weak medium subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine, fine, and medium and common coarse roots; many very fine irregular pores; about 30 percent pebbles; NaF pH less than 9.0; very strongly acid; abrupt smooth boundary.

Bs1-1 to 6 inches; strong brown (7.5YR 4/6) very gravelly loam, reddish yellow (7.5YR 6/6) dry; dark reddish brown (5YR 3/3) organic stains on faces of peds, reddish brown (5YR 4/4) dry; weak medium subangular blocky structure parting to weak medium granular; soft, friable, nonsticky and nonplastic; weakly smeary; many fine and medium and common very fine and coarse roots; many very fine irregular pores; about 30 percent pebbles and 10 percent cobbles; NaF pH 11.0; strongly acid; clear wavy boundary.

Bs2-6 to 14 inches thick; strong brown (7.5YR 4/6) very gravelly loam, reddish yellow (7.5YR 6/6) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and nonplastic; weakly smeary; few very fine and fine roots; common very fine irregular pores; about 40 percent pebbles and 15 percent cobbles; NaF pH 10.0; strongly acid; clear irregular boundary.

Bs3-14 to 22 inches; dark yellowish brown (10YR 4/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; very few very fine and fine roots; common very fine irregular pores; about 40 percent pebbles and 15 percent cobbles; NaF pH 10.0; strongly acid; abrupt smooth boundary.

2C-22 to 27 inches; grayish brown (2.5Y 5/2) very gravelly sandy loam, light brownish gray (2.5Y 6/2) dry; massive; slightly hard, firm, nonsticky and nonplastic; few very fine irregular pores; about 40 percent pebbles and 10 percent cobbles; NaF pH 9.8; slightly acid; abrupt smooth boundary.

2Cr-27 to 60 inches; dark yellowish brown (10YR 4/4), dense, compact glacial till that breaks to very gravelly loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm, nonsticky and nonplastic; few

very fine irregular pores; about 40 percent pebbles; NaF pH 10.5; slightly acid.

The depth to dense glacial till ranges from 20 to 40 inches. The thickness of the solum is 13 to 30 inches. The content of rock fragments in the control section ranges from 45 to 75 percent. It includes 5 to 20 percent cobbles.

The E horizon has hue of 5YR or 7.5YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist and dry.

The Bs1 horizon has hue of 5YR or 7.5YR, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 3 to 6 when moist and dry. It is very gravelly loam or extremely gravelly loam. The Bs2 and Bs3 horizons have hue of 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 and dry.

The C 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 6 when moist and dry. It is very gravelly loam, very gravelly sandy loam, or extremely gravelly loam.

The 2Cr 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 and dry. It is dense glacial till that breaks to very gravelly loam, very gravelly sandy loam, or extremely gravelly loam.

#### **Vanzandt Series**

The Vanzandt series consists of moderately deep, moderately well drained soils formed in volcanic ash, loess, and slope alluvium over glacial till derived dominantly from phyllite. These soils are on low mountain toe slopes and in valleys. Slopes are 5 to 60 percent. The mean annual precipitation is 50 to 70 inches, and the mean annual temperature is about 47 degrees F.

These soils are loamy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Vanzandt very gravelly loam, 5 to 15 percent slopes, 2 miles northeast of Acme, 400 feet south and 2,200 feet east of the northwest corner of sec. 33, T. 38 N., R. 5 E.

Oi-1 inch to 0; undecomposed needles, leaves, and twigs; many medium roots.

E-0 to 1.5 inches; dark brown (7.5YR 3/2) very gravelly silt loam, brown (7.5YR 5/2) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common medium and coarse roots; many fine irregular pores; about 25 percent hard pebbles and 20 percent channers; strongly acid; clear smooth boundary.

Bs1-1.5 to 10 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, slightly sticky and slightly plastic; weakly smeary; many very fine, fine, medium, and coarse roots; many fine irregular pores; about 25 percent hard pebbles and 10 percent channers; NaF pH 11.0; moderately acid; abrupt smooth boundary.

Bs2-10 to 23 inches; dark yellowish brown (10YR 4/4) very gravelly loam, very pale brown (10YR 7/4) dry; weak fine and medium subangular blocky structure; soft, friable, nonsticky and nonplastic; weakly smeary; many fine, medium, and coarse roots; many fine irregular pores; about 40 percent hard pebbles and 10 percent soft pebbles; NaF pH 11.0; moderately acid; clear smooth boundary.

C-23 to 31 inches; light yellowish brown (2.5Y 6/4) very gravelly loam, white (2.5Y 8/2) dry; few fine prominent strong brown (7.5YR 5/6) mottles, reddish yellow (7.5YR 6/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; many fine and medium roots; common fine irregular pores; about 30 percent hard pebbles and 10 percent channers; NaF pH 9.6; moderately acid; abrupt smooth boundary.

2Cd-31 to 60 inches; light brownish gray (2.5Y 6/2), dense glacial till that breaks to very gravelly loam, white (2.5Y 8/2) dry; common fine prominent strong brown (7.5YR 5/6) mottles, reddish yellow (7.5YR 6/6) dry; massive; very hard, very firm, nonsticky and nonplastic; few fine irregular pores; about 35 percent hard pebbles and 10 percent channers; moderately acid.

The depth to dense glacial till ranges from 24 to 40 inches. The thickness of the solum and of the part of the profile influenced by volcanic ash is 17 to 28 inches. The content of clay in the lower part of the control section is 10 to 15 percent. The content of rock fragments in the control section ranges from 40 to 50 percent hard rock fragments and from 0 to 10 percent weathered pebbles in the upper part and from 40 to 60 percent rock fragments in the lower part. The lower part includes pebbles, channers, and cobbles.

The E 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 and dry. Some pedons have an A horizon and do not have an E horizon.

The Bs horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist and dry. It is very gravelly loam or very gravelly silt loam.

Some pedons have a 2CB horizon.

The C horizon has hue of 2.5Y or 5Y, value of 5 to 8

when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist and dry. It is very gravelly loam or very gravelly sandy loam.

The 2Cd horizon has hue of 2.5Y or 5Y, value of 6 to 8 when moist and 5 to 8 when dry, and chroma of 2 to 4 when moist and dry. It is dense glacial till that breaks to very gravelly loam or very gravelly sandy loam.

## Welcome Series

The Welcome series consists of deep, well drained soils formed in a mixture of volcanic ash, glacial till, colluvium, and slope alluvium derived from sandstone. These soils are on mountain ridges and shoulder slopes. Slopes are 5 to 60 percent. The average annual precipitation is 55 to 65 inches, and mean annual air temperature is about 44 degrees F.

These soils are coarse-loamy, mixed, frigid Typic Haplothods.

Typical pedon of Welcome loam, 5 to 30 percent slopes, 2 miles southeast of Van Zandt, 2,000 feet north and 1,900 feet west of the southeast corner of sec. 21, T. 38 N., R. 3 E.

Oi-3 to 2 inches; undecomposed needles, leaves, and twigs.

Oa-2 inches to 0; decomposed forest litter.

E-0 to 2 inches; dark brown (10YR 4/3) silt loam, light gray (10YR 7/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and common medium roots; many very fine irregular pores; about 20 percent weathered pebbles; NaF pH 9.4; strongly acid; abrupt wavy boundary.

Bs1-2 to 6 inches; dark yellowish brown (10YR 3/4) loam, light yellowish brown (10YR 6/4) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; about 20 percent weathered pebbles, 5 percent hard pebbles, and 5 percent hard cobbles; NaF pH 10.5; common very fine, many fine and medium, and few coarse roots; many very fine irregular pores; strongly acid; clear wavy boundary.

Bs2-6 to 19 inches; dark yellowish brown (10YR 3/6) loam, very pale brown (10YR 7/4) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; about 30 percent weathered pebbles, 10 percent hard pebbles, and 5 percent weathered cobbles; NaF pH 11.0; many very fine and fine, common medium, and few coarse roots; many very fine irregular pores; strongly acid; abrupt wavy boundary.

C1-19 to 27 inches; light olive brown (2.5Y 5/6) sandy loam, pale yellow (2.5Y 8/4) dry; massive; soft, very

friable, nonsticky and nonplastic; weakly smeary; about 30 percent weathered pebbles, 5 percent hard pebbles, and 10 percent weathered cobbles; NaF pH 10.5; few very fine and common fine roots; many very fine irregular pores; strongly acid; clear wavy boundary.

C2-27 to 50 inches; light olive brown (2.5Y 5/6) fine sandy loam, pale yellow (2.5Y 7/4) dry; massive; soft, very friable, nonsticky and nonplastic; weakly smeary; about 20 percent weathered pebbles, 5 percent hard pebbles, 5 percent weathered cobbles, and 5 percent hard cobbles; NaF pH 10.5; few fine roots; common very fine irregular pores; strongly acid; abrupt wavy boundary.

2Cr-50 inches; sandstone; root mat of fine and medium roots overlies bedrock.

The depth to sandstone is 40 to 60 inches. The content of rock fragments in the control section ranges from 30 to 50 percent weathered pebbles, from 0 to 10 percent hard pebbles, and from 5 to 15 percent weathered cobbles.

The E horizon has value of 3 or 4 when moist and 6 or 7 when dry and chroma of 2 or 3 when moist and dry.

The Bs horizon has value of 3 or 4 when moist and 5 to 7 when dry and chroma of 4 to 6 when moist and dry. It is loam or silt loam.

The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 4 to 6 when moist and dry. It is sandy loam or fine sandy loam.

### Whatcom Series

The Whatcom series consists of very deep, moderately well drained soils formed in a mixture of loess and volcanic ash over glaciomarine drift. These soils are in the higher areas of glaciomarine drift plains. Slopes are 0 to 60 percent. The average annual precipitation is 35 to 55 inches, and the average annual air temperature is about 50 degrees F.

These soils are fine-loamy, mixed, mesic Aqualfic Haplothods.

Typical pedon of Whatcom silt loam, in an area of Whatcom-Labounty silt loams, 0 to 8 percent slopes; 7 miles northeast of Bellingham, 20 feet north and 600 feet east of the southwest corner of sec. 30, T. 39 N., R. 4 E.

Ap-0 to 9 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and common fine roots;

many very fine irregular pores; about 5 percent pebbles and 2 percent concretions; NaF pH 10.5; moderately acid; abrupt smooth boundary.

Bs1-9 to 13 inches; dark brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots; many very fine irregular pores; about 5 percent pebbles and 1 percent concretions; NaF pH 11.5; moderately acid; clear smooth boundary.

Bs2-13 to 16 inches; dark brown (7.5YR 3/4) silt loam, light brown (7.5YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots; many very fine irregular pores; about 5 percent pebbles and 1 percent concretions; NaF pH 12.0; moderately acid; abrupt smooth boundary.

2Bt1-16 to 20 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; many medium prominent dark yellowish brown (10YR 4/4) mottles, yellowish brown (10YR 5/4) dry; moderate thick platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; few thin patchy clay films on faces of peds; about 5 percent pebbles; NaF pH 9.8; moderately acid; clear smooth boundary.

2Bt2-20 to 26 inches; light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) dry; many coarse prominent yellowish brown (10YR 5/6) mottles, reddish yellow (7.5YR 6/6) dry; moderate thick platy structure; slightly hard, friable, nonsticky and slightly plastic; few very fine roots; many very fine irregular pores; few thin patchy clay films on faces of peds; about 10 percent pebbles; NaF pH 10.0; moderately acid; abrupt smooth boundary.

2C1-26 to 35 inches; light olive gray (5Y 6/2) loam, white (5Y 8/2) dry; many medium prominent mottles, light olive brown (2.5Y 5/6) moist and dry; moderate thick platy structure; very hard, firm, slightly sticky and slightly plastic; common very fine irregular pores; about 5 percent pebbles; NaF pH 9.4; neutral; clear smooth boundary.

2C2-35 to 60 inches; dark gray (5Y 4/1) loam, light gray (5Y 7/1) dry; moderate coarse blocky structure; extremely hard, very firm, slightly sticky and slightly plastic; very few very fine irregular pores; about 5 percent pebbles; NaF pH 9.6; mildly alkaline; slightly effervescent.

The thickness of the part of the profile influenced by volcanic ash and the depth to the 2C horizon are 14 to 28 inches. The content of rock in the particle-size control section ranges from 0 to 10 percent in the upper part and from 5 to 25 percent in the lower part. The

lower part of the control section ranges from 18 to 30 percent clay by weighted average.

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 and 3 or 4 when dry.

The Bs 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 and dry. The 2Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist and dry. It is dominantly loam, gravelly loam, clay loam, gravelly clay loam, or silty clay loam. In some pedons, however, it has thin strata of sandy 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 1 or 2 when moist and dry. It is dominantly loam, gravelly loam, clay loam, gravelly clay loam, or silty clay loam. It is blocky or massive. In some pedons, however, it has thin strata of sandy loam.

### Whitehorn Series

The Whitehorn series consists of very deep, poorly drained soils formed in volcanic ash, loess, glaciofluvial deposits, and glaciomarine drift. These soils are on wave-reworked glaciomarine drift plains. Slopes are 0 to 2 percent. The average annual precipitation is 30 to 40 inches, and the mean annual air temperature is about 50 degrees F.

These soils are fine-loamy, mixed, mesic Typic Umbraqualfs.

Typical pedon of Whitehorn silt loam, 0 to 2 percent slopes, 3 miles west of Ferndale, 1,000 feet south and 200 feet east of the northwest corner of sec. 35, T. 39 N., R. 1 E.

Ap-0 to 10 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; NaF pH 9.4; moderately acid; abrupt wavy boundary.

ABg-10 to 14 inches; dark brown (10YR 3/3) loam, grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) dry; many fine distinct dark yellowish brown (10YR 3/6 and 4/6) mottles, yellowish brown (10YR 5/6) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine irregular pores; NaF pH 9.4; moderately acid; clear wavy boundary.

BAG-14 to 18 inches; dark grayish brown (10YR 4/2) and light olive brown (2.5Y 5/4) very fine sandy loam, light gray (10YR 7/2) and light yellowish

brown (10YR 6/4) dry; many coarse prominent dark yellowish brown (10YR 3/4) and strong brown (7.5YR 4/6) mottles, brownish yellow (10YR 6/6) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots; many very fine irregular pores; about 5 percent pebbles; slightly acid; clear wavy boundary.

Bg-1 8 to 26 inches; dark brown (10YR 4/3) and grayish brown (10YR 5/2) very gravelly sandy loam, pale brown (10YR 6/3) and light gray (10YR 7/2) dry; many coarse prominent dark yellowish brown (10YR 4/6) mottles, brownish yellow (10YR 6/6) and reddish yellow (7.5YR 6/6) dry; weak fine subangular blocky structure; hard, friable, nonsticky and nonplastic; few very fine and fine roots; many very fine irregular pores; about 35 percent pebbles; slightly acid; abrupt wavy boundary.

Btg-26 to 33 inches; olive brown (2.5Y 4/4) and grayish brown (2.5Y 5/2) loam, light yellowish brown (10YR 6/4) and light gray (2.5Y 7/2) dry; many medium prominent dark yellowish brown (10YR 4/6) mottles, brownish yellow (10YR 6/6) dry; massive; very hard, firm, slightly sticky and slightly plastic; about 5 percent pebbles; neutral; clear wavy boundary.

2C-33 to 60 inches; olive brown (2.5Y 4/4) and brown (10YR 5/3) silt loam, very pale brown (10YR 7/3) and light gray (2.5Y 7/2) dry; common fine prominent dark yellowish brown (10YR 4/6 and 3/4) mottles, brownish yellow (10YR 6/6) dry; massive; very hard, very firm, slightly sticky and slightly plastic; about 5 percent pebbles; neutral.

The thickness of the solum is 20 to 40 inches. Depth to the Bg horizon is 16 to 24 inches. By weighted average, the particle-size control section has 10 to 18 percent clay and 0 to 15 percent pebbles, although the Bg horizon contains 0 to 40 percent pebbles.

The A and AB horizons have hue of 7.5YR or 10YR, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and dry. The A horizon is mottled in some pedons.

The BAG horizon has hue of 10YR or 2.5Y, value of 4 to 6 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist and dry. It is loam, silt loam, or very fine sandy loam. The Bg 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 dry. It is sandy loam, gravelly loam, gravelly sandy loam, or very gravelly sandy loam. The Btg and 2C horizons have hue of 10YR to 5Y, value of 4 to 6 when moist and 6 to 8 when dry, and chroma of 2 to 4 when moist and dry. They are loam, silt loam, clay loam, or silty clay loam.

## Wickersham Series

The Wickersham series consists of very deep, well drained soils formed in alluvium derived dominantly from phyllite. These soils are on alluvial fans and terraces. Slopes are 0 to 8 percent. The average annual precipitation is 55 to 65 inches, and the mean annual air temperature is about 49 degrees F.

These soils are coarse-loamy over sandy or sandy-skeletal, mixed, mesic Dystric Xerochrepts.

Typical pedon of Wickersham channery silt loam, 0 to 8 percent slopes, 0.5 mile west of Wickersham, 2,400 feet north and 900 feet west of the southeast corner of sec. 31, T. 37 N., R. 5 E.

- A1-0 to 4 inches; very dark gray (5Y 3/1) channery silt loam, gray (5Y 5/1) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine, few fine, and many medium roots; many very fine irregular pores; about 30 percent channers; strongly acid; clear smooth boundary.
- A2-4 to 12 inches; dark gray (5Y 4/1) channery silt loam, gray (5Y 6/1) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many fine and medium and few coarse roots; many very fine irregular pores; about 15 percent channers; moderately acid; clear smooth boundary.
- Bw-12 to 21 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak fine subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; common very fine and many fine and medium roots; many very fine irregular pores; about 5 percent channers; strongly acid; clear smooth boundary.
- 2C1-21 to 38 inches; dark gray (5Y 4/1) extremely channery loamy sand, gray (5Y 6/1) dry; single grain; loose, friable, nonsticky and nonplastic; few very fine and common fine roots; many very fine irregular pores; about 50 percent channers and 20 percent pebbles; moderately acid; clear smooth boundary.
- 2C2-38 to 44 inches; dark gray (5Y 4/1) channery sandy loam, gray (5Y 6/1) dry; massive; soft, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine irregular pores; about 15 percent channers and 5 percent pebbles; moderately acid; clear smooth boundary.
- 2C3-44 to 60 inches; dark gray (5Y 4/1) very channery loamy sand, gray (5Y 6/1) dry; single grain; loose, friable, nonsticky and nonplastic; few very fine roots; many fine irregular pores; about 50 percent channers and 10 percent pebbles; moderately acid.

The thickness of the solum and the depth to the 2C horizon are 15 to 30 inches. The content of rock fragments ranges from 5 to 25 percent in the upper part of the control section and from 40 to 70 percent in the lower part. The content of clay in the upper part of the particle-size control section ranges from 6 to 18 percent.

The A horizon has hue of 2.5Y or 5Y, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 1 or 2 when moist and 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 1 or 2 when moist and dry. It is silt loam, loam, or channery silt loam.

The 2C horizon has hue of 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 and dry. It is very channery loamy sand, extremely channery loamy sand, channery sandy loam, or sand.

## Winston Series

The Winston series consists of very deep, well drained soils formed in a mixture of loess and volcanic ash over glacial outwash. These soils are on outwash terraces. Slopes are 0 to 40 percent. The average annual precipitation is 55 to 70 inches, and the mean annual air temperature is about 48 degrees F.

These soils are coarse-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplorthods.

Typical pedon of Winston silt loam, 0 to 3 percent slopes, 4.5 miles north of Maple Falls, 400 feet south and 2,600 feet west of the northeast corner of sec. 1, T. 40 N., R. 5 E.

- Oi-2 inches to 1 inch; undecomposed needles, twigs, and dead moss.
- Oa-1 inch to 0; decomposed forest litter; many fine and common very fine, medium, and coarse roots.
- A-0 to 2 inches; dark reddish brown (5YR 3/3) silt loam, reddish brown (5YR 5/3) dry; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; many very fine, fine, medium, and coarse roots; many fine irregular pores; about 5 percent fine pebbles; NaF pH 10.5; slightly acid; abrupt smooth boundary.
- Bs1-2 to 6 inches; dark brown (7.5YR 3/4) silt loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, firm, nonsticky and slightly plastic; weakly smeary; common very fine, fine, medium, and coarse roots; common fine irregular pores; 5 percent concretions and 5 percent pebbles; NaF pH 11.5; slightly acid; clear smooth boundary.

Bs2-6 to 11 inches; dark brown (7.5YR 3/4) loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; slightly hard, firm, nonsticky and slightly plastic; weakly smeary; common very fine and fine and few medium and coarse roots; common very fine irregular pores; about 5 percent fine pebbles; NaF pH 11.5; moderately acid; clear smooth boundary.

Bs3-11 to 19 inches; dark yellowish brown (10YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) dry; weak fine subangular structure; slightly hard, firm, nonsticky and slightly plastic; weakly smeary; common very fine and fine and few medium and coarse roots; common fine irregular pores; about 10 percent fine angular pebbles and 5 percent fine rounded pebbles; NaF pH 11.5; moderately acid; gradual smooth boundary.

2CB-19 to 25 inches; dark yellowish brown (10YR 3/6) very gravelly loamy sand, yellowish brown (10YR 5/4) dry; massive; soft, friable, nonsticky and nonplastic; weakly smeary; few very fine and fine roots; common fine irregular pores; about 40 percent fine angular pebbles and 15 percent rounded pebbles; NaF pH 11.0; moderately acid; abrupt smooth boundary.

2C-25 to 60 inches; very dark grayish brown (10YR 3/2) extremely gravelly sand, pale brown (10YR 6/3) dry; single grain; loose; very few very fine roots; many fine and medium irregular pores; about 35 percent angular pebbles and 25 percent rounded pebbles; slightly acid.

The thickness of the solum and of the part of the profile influenced by volcanic ash and the depth to the 2C horizon range from 14 to 30 inches. The content of rock fragments in the particle-size control section ranges from 5 to 35 percent in the upper part and from 40 to 70 percent in the lower part.

The A horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 2 to 4 when moist and dry.

The Bs horizon has hue of 5YR to 10YR, 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. It is silt loam, loam, gravelly silt loam, or gravelly loam.

The 2CB horizon has value of 3 or 4 when moist and 5 or 6 when dry and chroma of 4 to 6 when moist and dry. The 2C horizon has hue of 10YR to 5Y, value of 4 to 6 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist and dry. It is very gravelly or extremely gravelly sand or loamy sand. It includes layers of stratified coarse sand or sandy loam.

## Wiseman Series

The Wiseman series consists of very deep, somewhat excessively drained soils formed in alluvium derived from phyllite. These soils are on alluvial fans. Slopes are 0 to 8 percent. The average annual precipitation is 55 to 65 inches, and the mean annual air temperature is about 48 degrees F.

These soils are sandy-skeletal, mixed, mesic Dystric Xerorthents.

Typical pedon of Wiseman very channery sandy loam, 0 to 8 percent slopes, 0.5 mile west of Wickersham, 2,300 feet south and 2,200 feet east of the northwest corner of sec. 31, T. 37 N., R. 5 E.

Oi-6 to 5 inches; undecomposed grass, moss, and twigs.

Oa-5 inches to 0; decomposed grass, moss, and wood ash; common very fine and fine roots.

A-0 to 4 inches; dark brown (7.5YR 3/4) channery loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine and fine and few medium roots; many fine irregular pores; about 30 percent channers; strongly acid; clear smooth boundary.

C1-4 to 20 inches; dark yellowish brown (10YR 3/4) very channery loamy sand, brownish yellow (10YR 6/6) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and few medium roots; many fine irregular pores; about 55 percent channers; moderately acid; clear smooth boundary.

C2-20 to 26 inches; dark yellowish brown (10YR 3/4) very channery sand, yellowish brown (10YR 5/4) dry; single grain; loose; common very fine and fine and few medium roots; many fine irregular pores; about 40 percent channers; strongly acid; clear smooth boundary.

C3-26 to 35 inches; dark grayish brown (2.5Y 4/2) very channery sand, pale yellow (2.5Y 7/4) dry; single grain; loose; common very fine and fine and few medium roots; many fine irregular pores; about 55 percent channers; moderately acid; clear smooth boundary.

C4-35 to 60 inches; grayish brown (2.5Y 5/2) very channery sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; few very fine, medium, and coarse roots; many fine and medium irregular pores; about 50 percent channers; moderately acid.

The thickness of the solum is 2 to 8 inches. The content of phyllite rock fragments in the particle-size

control section ranges from 45 to 80 percent.

The A 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 or 4 when moist and dry.

The C horizon has hue of 10YR to 5Y, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 2 to 4 when moist and dry. It is very channery or extremely channery sand or loamy sand.

### **Wollard Series**

The Wollard series consists of moderately deep, moderately well drained soils formed in a mixture of volcanic ash, colluvium, and slope alluvium over glacial till dominated by phyllite. These soils are on mountain back slopes. Slopes are 30 to 60 percent. The average annual precipitation is 75 to 85 inches, and the mean annual air temperature is about 42 degrees F.

These soils are fine-loamy, mixed, Typic Cryorthods.

Typical pedon of Wollard gravelly silt loam, 30 to 60 percent slopes, 6 miles east of Acme, 300 feet south and 100 feet west of the northeast corner of sec. 18, T. 37 N., R. 6 E.

Oa-7 to 6 inches; undecomposed needles, leaves, and twigs.

Oi-6 inches to 0; decomposed needles, leaves, and twigs; many very fine and fine and few medium roots.

E-0 to 1 inch; brown (7.5YR 5/2) gravelly loam, pinkish gray (7.5YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine roots; many very fine irregular pores; about 15 percent pebbles; NaF pH 10.0; extremely acid; abrupt smooth boundary.

Bhs-1 to 2 inches; yellowish brown (10YR 5/6) gravelly silt loam, brownish yellow (10YR 6/6) dry; dusky red (2.5YR 3/2) organic stains, reddish brown (2.5YR 4/4) dry; moderate medium subangular blocky structure; slightly hard, very firm, nonsticky and nonplastic; weakly smeary; many very fine roots; many very fine irregular pores; about 15 percent pebbles; NaF pH 11.0; very strongly acid; abrupt smooth boundary.

Bs-2 to 9 inches; yellowish brown (10YR 5/6) gravelly silt loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine and few fine roots; many very fine irregular pores; about 25 percent pebbles; NaF pH 12.0; strongly acid; clear smooth boundary.

C-9 to 30 inches; light brownish gray (2.5Y 6/2) gravelly loam, white (2.5Y 8/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic;

weakly smeary; few very fine roots; many very fine irregular pores; about 30 percent pebbles; NaF pH 11.0; strongly acid; clear smooth boundary.

2Cd-30 to 60 inches; light brownish gray (2.5Y 6/2), dense glacial till that breaks to gravelly loam, white (2.5Y 8/2) dry; massive; hard, very firm, slightly sticky and slightly plastic; about 30 percent pebbles; NaF pH 11.0; strongly acid.

The depth to dense, compact glacial till is 20 to 40 inches. The content of rock fragments in the particle-size control section ranges from 15 to 35 percent pebbles and channers.

The E horizon has hue of 7.5YR or 10YR, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist and dry.

The Bhs and Bs horizons have hue of 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 and dry. They are gravelly loam or gravelly silt loam.

The C and 2Cd 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 and dry. The C horizon is gravelly loam or gravelly clay loam, and the 2Cd horizon is dense glacial till that breaks to the same textures.

### **Woodlyn Series**

The Woodlyn series consists of shallow, poorly drained soils formed in a mixture of loess and volcanic ash over glacial outwash. These soils are on outwash terraces and outwash plains. Slopes are 0 to 2 percent. The average annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

These soils are loamy, mixed, mesic, ortstein, shallow Typic Sideraquods.

Typical pedon of Woodlyn loam, in an area of Edmonds-Woodlyn loams, drained, 0 to 2 percent slopes; 4 miles north of Ferndale, 2,400 feet north and 1,500 feet west of the southeast corner of sec. 6, T. 39 N., R. 2 E.

Ap-0 to 9 inches; dark brown (7.5YR 3/2) loam, light brownish gray (10YR 6/2) dry; weak fine granular and weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine irregular pores; NaF pH 9.4; strongly acid; clear smooth boundary.

E-9 to 12 inches; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) loam, light brownish gray (10YR 6/2) dry; few fine distinct yellowish brown

(10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure parting to weak fine granular; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; NaF pH 10.0; moderately acid; abrupt smooth boundary.

2Bsm1-12 to 17 inches; dark grayish brown (10YR 4/2), indurated ortstein pan that breaks to loamy sand, light brownish gray (10YR 6/2) dry; many coarse prominent dark brown (7.5YR 4/4) mottles, reddish yellow (7.5YR 6/6) dry; massive; extremely hard, extremely firm, nonsticky and nonplastic; few very fine roots in cracks; few very fine irregular pores; moderately acid; clear smooth boundary.

2Bsm2-17 to 25 inches; dark brown (10YR 3/3), weakly cemented ortstein pan that breaks to loamy sand, pale brown (10YR 6/3) dry; few fine distinct yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry; massive; hard, firm, nonsticky and nonplastic; few very fine irregular pores; moderately acid; abrupt smooth boundary.

2C1-25 to 38 inches; coarse sand that is dominantly brown (10YR 5/3) but is variegated; white (10YR 8/2) dry; single grain; loose; many very fine irregular pores; moderately acid; clear smooth boundary.

2C2-38 to 60 inches; coarse sand that is dominantly olive gray (5Y 4/2) but is variegated; light gray (5Y 7/1) dry; single grain; loose; many very fine irregular pores; moderately acid.

The depth to the strongly cemented ortstein pan is 10 to 14 inches. The particle-size control section has 10 to 18 percent clay by weighted average.

The Ap horizon has hue of 7.5YR or 10YR, value of 3 or 4 when moist and 6 or 7 when dry, and chroma of 1 to 3 when moist and dry. Pedons in uncultivated areas have an A horizon 3 to 7 inches thick, similar to the Ap horizon.

The E horizon has hue of 7.5YR or 10YR, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist and dry. It is loam or sandy loam.

The 2Bsm1 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 4 when moist and dry. It is a strongly cemented ortstein pan that breaks to loamy sand or sand. It is very hard or extremely hard when dry and very firm or extremely firm when moist.

The 2Bsm2 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 4 when moist and dry. It is continuously weakly cemented and is slightly hard or hard. It breaks to loamy sand or sand. Some pedons have a 213s horizon

that has 15 to 35 percent ortstein concretions 0.25 inch to 2 inches in diameter. This horizon is slightly hard or hard.

The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 or 4 when moist and 6 or 7 when dry, and chroma of 2 or 3 when moist and dry.' It is coarse sand or sand.

## Yelm Series

The Yelm series consists of very deep, moderately well drained soils formed in a mixture of volcanic ash and loess over glaciofluvial deposits. These soils are on terraces. Slopes are 0 to 8 percent. The mean annual precipitation is 30 to 50 inches, and the mean annual air temperature is about 50 degrees F.

These soils are coarse-loamy, mixed, mesic Aquic Haplothods.

Typical pedon of Yelm loam, 3 to 8 percent slopes, 4 miles northwest of Ferndale, 2,600 feet north and 1,000 feet east of the southwest corner of sec. 1, T. 39 N., R. 1 E.

Ap-0 to 8 inches; dark brown (7.5YR 3/2) loam, yellowish brown (10YR 5/4) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and common medium roots; many very fine irregular pores; NaF pH 10.5; slightly acid; clear smooth boundary.

Bs1-8 to 15 inches; dark brown (7.5YR 4/4) loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine roots; many very fine irregular pores; NaF pH 11.0; slightly acid; clear smooth boundary.

Bs2-15 to 30 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and common fine roots; many very fine irregular pores; NaF pH 11.5; slightly acid; clear smooth boundary.

BC-30 to 36 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) loam, light yellowish brown (10YR 6/4) and very pale brown (10YR 7/3) dry; common medium distinct strong brown (7.5YR 5/6) mottles, yellowish brown (10YR 5/6) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine roots; many very fine irregular pores; NaF pH 11.0; moderately acid; clear smooth boundary.

2C1-36 to 50 inches; light brownish gray (2.5Y 6/2) and pale brown (10YR 6/3) very fine sandy loam, light gray (2.5Y 7/2) and very pale brown (10YR 7/4) dry; many medium prominent yellowish red (5YR 5/8) mottles, strong brown (7.5YR 5/8) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; NaF pH 11.0; moderately acid; clear smooth boundary.

2C2-50 to 60 inches; light gray (2.5Y 7/2) and light olive brown (2.5Y 5/4) very fine sandy loam, white (2.5Y 8/2) and pale yellow (2.5Y 7/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; NaF pH 10.5; slightly acid.

The thickness of the part of the profile influenced by volcanic ash and the depth to the 2C horizon range from 20 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 and dry.

The Bs 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 and dry. It is loam, fine sandy loam, or very fine sandy loam.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 7 when moist and 5 to 8 when dry, and chroma of 2 to 4 when moist and dry. It is loam, fine sandy loam, or very fine sandy loam or is stratified loamy sand, sandy loam, and silt loam.

# Formation of the Soils

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Soil is a dynamic, natural, three-dimensional body synthesized from mineral and organic materials that exist on the surface of the Earth. It provides air, water, root anchorage, and nutrients for plants.

Soil is a fundamental part of the ecosystem that is formed through the integrated effect of physical, biological, and chemical weathering of geological materials acting over time. Individual soils are characterized by their vertical sequence of layers, or horizons, which vary in such properties as color, texture, acidity, and the amount of rock fragments. Soils differ in their appearance, productivity, and management requirements in different locations and even over short distances. They can be distinguished by differences in the sequence and properties of their horizons. The characteristics and properties of the soil at any given place are determined by the interaction of five factors: the physical, chemical, and mineralogical composition of the parent material; the climatic conditions acting on the parent material during the evolution of the soil; the topography, or relief, of the landscape; the plant and animal life within and on the surface of the soil; and the age of the soil, or the length of time that the climate, topography, and biota have acted on the parent material.

The five factors are interdependent; the combined action of these forces results in soil formation, although one or two of them often predominate at a particular site. Climate and biota, particularly vegetation, are the active forces of soil formation. A particular set of soil-forming factors gives rise to a unique soil profile; as any one factor changes, so does the soil. Horizons are continually forming and evolving in response to environmental factors.

In the first part of this section, climate, living organisms, and topography are described separately. The factors of parent material and time are described in the sections "Geomorphic Surfaces" and "Geomorphic Unit."

Many of the soils in the survey area are very similar to soils in the Lower Fraser Valley in British Columbia (16, 17). The laboratory data for those soils and

additional information about their formation and characteristics are available (25, 26, 27).

## Climate

Climate has a strong influence on soil formation. Temperature and moisture greatly influence the kind and productivity of vegetation, the activity of microorganisms, and the rate at which organic matter decomposes and minerals weather. They also influence water movement through the soil and thus indirectly control the rate of removal (leaching) of soluble material from some soil horizons; the chemical state of certain elements, such as iron and manganese; and the rate of translocation and accumulation of materials into other horizons.

Climate also is largely responsible for the amount and intensity of soil erosion from uplands and for the deposition of soil material on lowlands and flood plains. Wind patterns and geographic distribution of rainfall affect the deposition pattern of eolian material.

Precipitation in the survey area occurs mostly between October and May. The amount and distribution of precipitation in the survey area is similar to that of soils in a xeric moisture regime. Soils on the poorly drained bottom land and in depressions on uplands are in an aquic moisture regime because high ground-water levels keep the soil saturated for prolonged periods. Most soils that receive more than 70 inches of precipitation in a year are moist throughout the year or are dry for less than 45 consecutive days; therefore, they have a udic moisture regime (18).

A climatic sequence of soils formed in a mixture of volcanic ash, loess, and phyllite colluvium shows the effects of climate on the amount of leaching and on the accumulation of organic matter, both increase with increasing elevation (30). While the other soil-forming factors are relatively constant (except as climate influences vegetation), the climate varies. For example, in areas of Squires, Rinker, Springsteen, Crinker, and Hinker soils, the mean annual temperature ranges from 48 to 51 degrees F and the mean annual precipitation ranges from 45 to 100 inches.

In the following paragraphs, the three general climatic zones of the survey area are described briefly. These zones are characterized by differences in the kind and amount of precipitation and in the mean annual air temperature. These differences, in turn, affect the type and abundance of vegetation that occurs and the amount of organic matter produced.

*Climatic Zone 1* includes general soil map units 1 through 11. Precipitation in this zone occurs mostly as rain between October and May. It ranges from 30 to 75 inches annually. Snow falls sporadically between December and February. Because the average annual soil temperature ranges from 47 to 50 degrees F, the soils in this zone are in the mesic temperature regime (43). During summer, the weather is warm and dry, and the soils are dry for a long period. As a result, the soils are in the xeric moisture regime. During winter, the weather is cool and moist and the soils are moist. Freezing occurs in the surface layer of most soils, particularly those which are bare.

Most of the better drained soils are Typic Haplorthods. They have a light colored surface layer (ochric epipedon) and an accumulation of iron and aluminum and some organic matter in the subsoil (spodic horizon). Typically, the surface layer of poorly drained soils in zone 1 has accumulated enough organic matter to qualify as an umbric or mollic epipedon. Some soils have an accumulation of clay in the subsoil. The soils in this zone are mainly Typic Umbraqualls or Typic Argiaquolls. The major exceptions are Edmonds and Woodlyn soils, which have a subsoil that is cemented with iron and that qualifies as a spodic horizon. The Edmonds and Woodlyn soils are Typic Sideraquods.

*Climatic Zone 2* includes general map units 12 and 13. The annual precipitation ranges from 45 to 85 inches. Snowfall dominates the precipitation from December through February, and the snow cover generally lasts through March. Because the average annual soil temperature ranges from 44 to 47 degrees F, the soils in this zone are in the frigid temperature regime. During summer, the weather is warm and dry and the soil temperature is above 47 degrees F. The soils are dry for shorter periods than the soils in zone 1. Low soil temperatures in winter reduce biological and chemical activity. Freezing is common in these soils.

Most of the soils in zone 2 are Typic Haplorthods, which have a light colored surface horizon (ochric epipedon) and a subsoil that has accumulated iron, aluminum, and organic matter (spodic horizon). Many of the soils have a leached surface layer (albic horizon) above the spodic horizon.

*Climatic Zone 3* includes general soil map unit 14. The annual precipitation, which is dominantly snow,

ranges from 75 to 105 inches. The snow cover can last through May. The upper part of the soil is very cold or frozen for as long as 6 months. In this zone soils tend to develop slowly because the cold temperatures suspend or significantly reduce the extent of biological and chemical activity. Frost action is common.

Summers are short, cool, and moist, and the soils never warm above 47 degrees F. Because the average annual temperature ranges from 40 to 46 degrees F, the soils in this zone are in the cryic temperature regime.

The soils in zone 3 are dominantly Cryorthods that have a thick organic mat, a leached surface layer (albic horizon), and an accumulation of translocated organic matter, iron, and aluminum in the subsoil (spodic horizon). Shuksan, Hinker, and Hartnit soils, which are Humic Cryorthods, are in the colder, wetter part of the zone. As a result, they have a thicker organic layer and a larger accumulation of organic matter in the subsoil than Getchell, Springsteen, and Wollard soils which are Typic Cryorthods. The Getchell, Springsteen, and Wollard soils are in the part of the zone that receives less precipitation and has higher temperatures. All of the soils in zone 3 have low bulk density, low percent base saturation, and high available water capacity relative to clay content.

## Living Organisms

Plants, micro-organisms, and animals are active forces in soil formation. Plants draw moisture and nutrients from the soil and improve aeration, soil structure, and permeability. They also intercept rainfall and mitigate its impact, thus helping to control runoff and erosion by stabilizing the soil. The remains of dead plants replenish the content of organic matter in the soil.

If moisture and temperatures are adequate, the soil becomes the medium in which simple forms of life grow and reproduce. Micro-organisms, such as fungi and bacteria, improve soil fertility by helping in the decomposition of organic matter and conversion of nutrients in plant litter to forms that are once again available to plants (7). Soils that are wet, cold, or both inhibit the growth of these aerobic soil fauna; as a result, organic matter accumulates more rapidly in them than in dry, warm soils. Wet soils, such as Bellingham soils, and cold soils, such as Shuksan soils, have a high content of organic matter.

Small animals, earthworms, and insects influence the formation of soil by mixing organic matter into the mineral soil material and by breaking down plant remains and accelerating the decomposition of the organic matter. Small animals burrow into the soil and

mix the layers. Earthworms and small vertebrates feed on the organic matter in the upper few inches of the soil material. They slowly, but continually, mix the soil material and sometimes alter its chemistry. Except at the higher elevations, the conditions in the survey area are favorable for most organisms to function.

Organic matter in the soil is the main source of nitrogen for plant growth and of organic acids that promote leaching of soils. High levels of organic matter in soils are indicated by black or dark brown colors. Applying manure, mixing organic matter into the surface layer of cropland, and converting forest land to pasture help to increase the organic matter content and darken the surface layer in soils, such as in the Whatcom, Edmonds, and Hale soils.

Organic soils, such as Pangborn, Shalcar, and Fishtrap soils, formed in bogs in the accumulated remains of water-tolerant plants, such as sedges, rushes, and mosses. These deposits are highly decomposed sapric material (muck), particularly where drained. Undrained areas contain less-decomposed hemic material (36). Drainage increases aeration and soil temperature, thereby improving the conditions for microbial activity and resulting in a greater decomposition of the organic material. Drainage causes the surface to subside and results in soil loss unless the soil is kept moist (7).

In the survey area, soils have formed under three major types of plant cover. In some places soils in the aquatic soil moisture regime had native vegetation consisting of mixed conifers and hardwoods that were tolerant to high water levels. In other places the vegetation was mainly sedges, rushes, and other water-tolerant plants. Labounty, Whitehorn, and Everson soils are examples of soils in this regime. They have a dark surface horizon that has a high content of organic matter and a gleyed, mottled B horizon that is a result of the low level of oxygen.

In the area that receives a lower amount of precipitation, the soils are moist in winter and dry in summer. This area is dominated by Douglas fir and western hemlock in the overstory and by a variety of shrubs in the undergrowth (15). Everett, Chuckanut, Oakes, and Montborne soils are examples of soils in this area. They have a lighter colored or thinner surface layer than that of the soils in the aquatic moisture regime. Their subsoil is also more leached and is redder because of greater aeration. Plants on soils in this area are subject to varying degrees of moisture stress in summer.

In the udic moisture regime, which receives more than 70 inches precipitation, the soils are moist almost year round and are cold because of higher elevation. Kindy, Saar, Kulshan, and Edfro soils are examples of

soils in this regime. The large amounts of organic matter, organic acids, and the leaching of bases have produced high acidity in these soils. Pacific silver fir, western hemlock, and mountain hemlock dominate the vegetation on these soils.

The major human activities that impact the soils in the survey area are urbanization, channelization of rivers, the installation of drainage systems, mining operations, timber harvesting, and timber regeneration. Timber harvesting mixes the duff and forest debris with the surface soil. Clearcutting, with or without burning, allows forbs, shrubs, and ferns to invade and grow and thus to alter the distribution of organic matter in the soils (15).

## Topography

Topography is a primary factor in soil variation (21). It includes relief, aspect, elevation, and drainage and largely determines the amount of water distribution and movement in the soil and the stability of soil material. Runoff increases with the steepness of slope; thus, deposition of soil is greater on toe slopes and valleys below steep slopes than it is on ridges, uplands, or broad, flat plains. Vegetation stabilizes the soil on slopes, helps to control erosion, and increases the rate of soil development. When soils are laid bare by timber harvesting or agriculture, the potential for erosion increases, particularly during periods of heavy rainfall. Sheet erosion mainly carries away surface soil. Rill and gully erosion can cut into the subsoil and substratum. Mass wasting on steep slopes can remove all soil above the regolith. It is particularly common on Andic Xerochrepts, Andic Cryochrepts, and Typic Cryorthods that have 60 to 90 percent slopes and on soils, such as Sehome, Cupples, Kindy, and Saar soils, that have the 45 to 60 percent slopes and are underlain by glacial till.

Aspect, or slope orientation, can play an important role in soil formation through its influence on available water (8). It can affect the distribution of organic carbon in the soil, the presence or absence of an E horizon, pH, and percent exchangeable bases (5). Effective precipitation is less on south- and west-facing slopes than on north- and east-facing slopes. Soil temperatures are higher on south- and west-facing aspects. These higher temperatures cause snow to melt and soils to warm sooner. As a result, the chance for moisture stress increases and plant and animal communities occur at higher elevations than on north- and east-facing aspects. On north-facing aspects in Whatcom County, the cryic temperature regime begins at about 1,800 feet; whereas on south-facing slopes, it begins at about 2,500. Generally, as elevation increases, snow cover and precipitation increase and

temperature and length of the frost-free season decrease.

Much of the nonmountainous part of the survey area consists of broad, nearly level glacial outwash and alluvial terraces and of rolling glaciomarine drift plains and proglacial lacustrine terraces that have slopes of less than 8 percent. As a result, differences in the relief of even a few feet can result in major differences in the level of the water table and thus in drainage class and soil formation.

Differences in relief result in the removal of runoff from higher parts of the landscape and the collection of water in swales, basins, and depressions. In the survey area, drainage is one of the most important factors in the distribution of soils and vegetation. Soils have differing properties as a result of differences in relief. For example, the Whatcom-Labounty and Skipopa-Bellingham catenas formed in a mixture of volcanic ash and loess over glaciomarine drift and volcanic ash and loess over glaciolacustrine sediments, respectively. The moderately well drained Whatcom and the somewhat poorly drained Skipopa soils are in the higher landscape positions. They have a dark brown or dark yellowish brown surface layer and subsoil. They have low bulk density and are moderately permeable (30, 32). The poorly drained Labounty and Bellingham soils have a dark brown to black surface layer that has a high content of organic matter and a gray, mottled subsoil that has a low content of organic matter and is high in bulk density. They are moderately slowly permeable or slowly permeable. Their subsoil can be hard and impermeable. The Labounty and Bellingham soils are ponded in winter unless the soils are drained, whereas the water table in Whatcom and Skipopa soils remains below a depth of 1 foot. The Whatcom and Skipopa soils support Douglas fir and a diverse ground cover. The Labounty and Bellingham soils support red alder, western redcedar, and more limited, moisture-tolerant types of ground cover. Other soil topographic transacts of this type are the Kickerville-Clipper, Birchbay-Whitehorn, Mt. Vernon-Briscot, and Lynden-Laxton-Tromp-Edmonds-Woodlyn catenas.

Soils on bottom land in the survey area formed in alluvium deposited by the runoff from surrounding uplands and from the floodwaters of adjacent streams and rivers that carried material down valleys from the higher elevations. The duration and frequency of flooding, the particle-size and stratification of the deposits, and the ability of the soils to drain excess water are the three conditions responsible for differences in soil development and land use on bottom land. The well drained Puyallup and the moderately well drained Mt. Vernon soils occur on levees. Because of their higher position on the landscape, they are less

seriously affected by flooding than the poorly drained Briscot, Oridia, Sumas, and Puget soils on the flood plain and the Eliza and Tacoma soils on the delta.

Topography, partly by its effect on vegetation, has a major influence on the weathering of the parent material and on the mineralogy of a soil (40). This effect can be seen in the alpine (6) as well as the nonmountainous parts of the survey area (32). The effects of podzolization and volcanic ash can be difficult to distinguish (37).

## Geomorphic Surfaces

The geomorphology and soils of the survey area reflect a sequence of depositional and erosional events that are the result of glacial and fluvial processes (17). Each sequence of erosion and deposition represents an episode in time that can be delineated as a set of geomorphic surfaces (31).

The soils associated with a particular geomorphic surface are recognized primarily by contrasts in the age and texture of the parent material.

The soils of the survey area vary considerably in age. Soil formation in unconsolidated material begins when the last sediments are deposited and the surface stabilizes to vegetation. It begins in bedrock or dense glacial till when that material has weathered to a permeable state. Soil material is in a dynamic state of formation. It is continuously being eroded and deposited on most sites.

Time is unique among the factors of soil formation because its influence is solely to allow the topography, biota, and climate to act on the parent material and to change that parent material into soil. Generally, the younger the soil, the more influential the parent material. As age increases, soil horizons form and become more distinctive.

None of the soils in the survey area have significant accumulations of translocated organics, clay, sodium, or carbonates in the subsoil. The annual precipitation of 30 to 60 inches has leached most of the soluble materials below the zone of observation. Whatcom soils have some carbonates. These carbonates are present in the marine sediment and are difficult to leach because of the slow permeability in the soils. The soils also have some argillans.

Structure is weak in most of the soils. The strongest structure in the subsoil is in the soils that have a high clay content, such as Bellingham soils, and in the Spodosols that have iron cementation, such as Edmonds and Woodlyn soils.

The major distinctive horizons in the survey area are the E and upper Bsm horizons in the poorly drained Spodosols and the Ap and Bg horizons in cultivated,

poorly drained soils. The well drained and moderately well drained soils on the two older surfaces have silt pellets and cracked coatings in the B horizon.

There are four geomorphic surfaces in the survey area. They are described as follows:

*Surface 1.* This surface consists of the lower, active flood plain of the Nooksack River. It is the depositional and erosional environment of the river channels and associated point bars and channel fillings. It is generally underlain by coarse alluvium and is subject to annual flooding. The deposits are pebbles, sand, and silt. The landscape configuration is not stable and changes rapidly as a result of water cutting new channels, abandoning older channels, and moving alluvial deposits downstream.

The age of the surface is late Holocene. Elevation ranges from sea level to 165 feet above sea level. Slopes are 0 to 3 percent. The principal soils on this surface are the Mt. Vernon soils, which are very deep, moderately well drained, and composed of unweathered sand with an admixture of volcanic ash in the upper part. Mt. Vernon soils, which are Fluvaquent Haploxerolls, have no diagnostic features other than a mollic epipedon (43). Riverwash also is a major component of this surface. Alluvial fans and coastal beach deposits are included in this unit. Some organic deposits occur in the quiet backwater areas. The parent material of the fans depends on the lithology at the source of the debris. Wickersham and Wiseman soils formed in phyllite alluvium, whereas Kline soils formed in a variety of materials. Neptune and Hovde soils are inextensive soils that formed in gravelly marine deposits having varying degrees of incorporated seashells.

*Surface 2.* This surface consists of the higher of the two flood plains and includes the levees, the valley flat, and the modern delta of the Nooksack River. The deposits generally are stratified sand, silt, and clay. The alluvium is derived from a variety of rocks but is dominated by andesite and metasedimentary material (12). Alluvial fans and coastal beach deposits are included in this surface. Some organic deposits occur in former quiet backwater areas. Elevation ranges from sea level to 200 feet above sea level. Slopes are dominantly 0 to 2 percent but are as steep as 8 percent on alluvial fans.

Deposition started on this surface after the Sumas Stage of the Fraser Glaciation about 10,000 years before the present. No properties associated with volcanic ash are evident in the soils. Since the ash in the western part of the survey area originates from Mount Mazama (12, 24), the lack of Mazama ash within this surface indicates that the surface is younger than 6,600 years. This surface is probably middle to late Holocene.

Soils of this surface have few prominent morphological features; they are differentiated mainly by the texture of the parent material. Most of the soils have a fluctuating water table, as indicated by mottling in the underlying material within a depth of 20 inches. The soils on the river terraces and flood plains are very deep, are nearly level, and have a mollic epipedon. The moderately well drained Mt. Vernon soils, which are Fluventic Haploxerolls, are examples of these soils.

The soils on the delta are very deep, are very poorly drained, and contain sulfidic material. The principal soils are the Eliza and Tacoma soils, which are subject to salt intrusion as a result of their proximity to the sea. The Eliza and Tacoma soils are Sulfic Fluvaquents.

The soils on the valley flat are very deep, poorly drained Aeric Fluvaquents. They include Briscot and Oridia soils. These soils and those on the delta have no diagnostic horizon other than an ochric epipedon.

*Surface 3.* This surface is dominantly outwash terraces but also includes proglacial lacustrine terraces. The outwash terraces consist of sand with various amounts of gravel. Depressions in the outwash terraces, both channels and kettles, commonly contain organic deposits. Lakebeds and low-relief, abandoned channels that are filled with organic material are typical of surfaces of this age in western Oregon (31) and south-central Washington (19), although the latter did not develop in glacial material. The glaciolacustrine deposits consist of silt and clay, which are distinctly varved in some areas. A thin layer of eolian material, which includes volcanic ash, mantles this surface (3).

Surface 3 is the oldest surface related to the present drainage system. The ancient drainage pattern parallels that of the modern flood plain indicating that the Nooksack River is a remnant of the preexisting glacial drainage system. The ability of the proglacial streams to carry material was greater than that of the modern Nooksack River, and the valley was broader, as is indicated by the deposits, which are coarser and more extensive than modern alluvial material. The texture of the soils reflects this difference.

The pro-glacial streams deposited material that has a high content of rock fragments. Kickerville, Barnhardt, and Clipper soils formed in this material. The slower moving waters deposited stratified sands and some silts that have a low content of rock fragments. These sediments were later reworked by wind. Lynnwood, Lynden, Laxton, Tromp, Hale, Edmonds, and Woodlyn soils formed in these deposits. The admixture of silty eolian deposits and organic matter into these soils has markedly increased their fertility (16). Elevation ranges from 50 to 300 feet. Slopes range from 0 to 15 percent.

Carbon-14 dates obtained from the base of the organic deposits range from 9,920 years (plus or minus

760) to 9,300 years (plus or minus 250) before the present (3, 12). The outwash and glaciolacustrine deposits are slightly older, and the surface is slightly younger, corresponding to late Pleistocene. Deposition occurred during the Sumas Stade of the Fraser Glaciation. The organic soils commonly contain strata of volcanic ash (36) from the eruption of Mount Mazama, as do soils of similar age in other areas of the Pacific Northwest (19, 31).

The soils on the outwash terraces are very deep to shallow, somewhat excessively drained to poorly drained, and nearly level to gently sloping. The lower part of the profile in these soils is sandy and contains 0 to 60 percent coarse fragments. The upper part of the profile of most of these soils formed in eolian deposits that include volcanic ash. Each of the soils on this surface has a spodic horizon. The principal soils are the well drained Lynden and Kickerville soils, which are Typic Haplorthods, and the moderately well drained Tromp and somewhat poorly drained Hale soils, which are Aquic Haplorthods. Also included are the poorly drained Edmonds and Woodlyn soils, which are Typic Sideraquods. A continuous hardpan (ortstein layer) that is strongly cemented with iron has developed within a depth of 20 inches in the Woodlyn soils. This layer, which formed from the deposition of iron at the water table, is fragmented in the Edmonds soils.

Upon glacial recession, meltwater flow decreased. Abandoned outwash channels and, to a lesser extent, kettles and other depressions on the flood plains supported wetland plants, such as rushes, sedges, and some woody plants, in the stagnant water (36). When the plant material died, it accumulated and became the parent material for the very deep, very poorly drained, nearly level Pangborn soils, which are Typic Medisaprists, and Shalcar and Fishtrap soils, both of which are Terric Medisaprists. The soils on the glaciolacustrine terraces are very deep, somewhat poorly drained and poorly drained, and nearly level to gently sloping. They are on ridge-swale topography. Skipopa soils, which are Aqualfic Haplorthods, are on the ridges. They have a silty eolian mantle over a clayey substratum. They have a spodic horizon and an argillic horizon. Bellingham soils, which are Mollic Haplaquepts, are in the swales. They have a mollic epipedon and an argillic horizon and are clayey throughout the control section.

**Surface 4.** This surface consists of glaciomarine deposits having an eolian mantle that includes volcanic ash (32). The rolling topography reflects the deposition from melting ice of debris that ranges in size from clay particles to boulders. In the western part of the survey area, poorly sorted glaciofluvial material as much as 24 inches thick lies between the eolian mantle and the

glaciomarine deposits. Elevation ranges from 65 to 400 feet. Slopes range from 0 to 60 percent.

The age of this surface has been determined from the dating of fossil shells in the glaciomarine deposits. Dates range from 12,090 years (plus or minus 350) to 10,370 years (plus or minus 300) before the present (3, 12). The material was deposited in the late Pleistocene during the Everson Interstade of the Fraser Glaciation prior to the inception of the Sumas Stade. Dates from marine terraces and peat bogs overlying these deposits show that the area was rapidly uplifted isostatically during this time (11).

On glaciomarine drift plains not overlaid by the glaciofluvial materials, the soils are very deep, moderately well drained and poorly drained, and nearly level to steep. Whatcom soils, which are Aqualfic Haplorthods, have a spodic horizon and an argillic horizon and are in the higher, steeper part of the landscape. Labounty soils, which are Typic Umbraqualfs, have an umbric epipedon and an argillic horizon and are in the lower part.

The soils with interbedded glaciofluvial deposits are very deep, moderately well drained and poorly drained, and nearly level to gently sloping. Birchbay soils, which are Typic Haplorthods, and Whitehorn soils, which are Typic Umbraqualfs, are similar in morphology and landscape position to Whatcom and Labounty soils, respectively, but have coarser textures in the upper part of the substratum.

Although clay films in the Whatcom, Labounty, Skipopa, Bellingham, and Whitehorn soils are uncommon, micromorphological evidence in the form of argillans indicates the development of an argillic horizon. The classification of the spodic horizon on surfaces 3 and 4 is based on the discovery by the USDA's Soil Survey Investigations Staff of silt-sized pellets and some cracked coatings in the B horizon. The soils do not meet the chemical criteria for a spodic horizon.

## Geomorphic Unit

The geomorphic unit has no age connotation; therefore, it is not considered a geomorphic surface. The topography is completely dissected and predominantly steeply sloping. Slopes are as much as 90 percent. Elevation ranges from 500 to 5,000 feet. The steep, broken topography may join any other surface, or it may make up large areas of mountainous terrain so thoroughly dissected that a geomorphic surface is not recognized. Erosion is active in much of the unit, and in some areas mass movement is evident. In some areas, however, occasional remnants of some older geomorphic surfaces are present. Many soils

contain volcanic ash and may be as old as surface 4; adjacent soils with active erosion are as young as surface 1. The variability in age makes this geomorphic unit useful in mapping areas of mountainous terrain.

For the most part, the rocks underlying the soils in this unit make up the oldest formations in the survey area, but as a rule, the soils are relatively immature and younger than the soils in gently sloping areas. The soils formed in colluvium, slope alluvium, and glacial till with an admixture of eolian deposits that include volcanic ash. In the very steep areas, erosion has been the main factor retarding soil formation. Among the factors affecting erosion are the length and steepness of the slope, the amount of water the soil can absorb and retain, and the type, amount, and duration of precipitation.

The lithology of the soils formed in the geomorphic unit is dominantly sandstone, which underlies Nati, Chuckanut, Revel, Welcome, and Kulshan soils; siltstone, which underlies Comar soils; metasedimentary rocks, which underlie Oso and Hartnit soils; and phyllite, which underlies Squires, Rinker, Springsteen, Crinker, and Hinker soils. Greywacke on Lummi Island, serpentine on Sumas and Bowman Mountains, and dunite on Twin Sisters Mountain are important in these specific areas. These rocks range in age from pre-Jurassic to Tertiary (13).

The most distinctive bedrock in the survey area is the dunite intrusion of the Twin Sisters Mountain. Soils that formed in these materials are high in magnesium, are low in calcium, and can have toxic levels of nickel, chromium, and cobalt. The vegetation on these soils is generally stunted because of a nutrient imbalance, calcium deficiency, and magnesium toxicity (35). The type and vigor of the vegetation on soils that formed in serpentine and dunite frequently differ considerably from the vegetation on adjacent soils that formed in different parent material (23).

The lithology of most of the glacial till is mixed. It is derived from a variety of Canadian sources. It includes granodiorite, andesite, chert, and metamorphic rocks (12). Squalicum, Cupples, and Shuksan soils are representative of the soils that formed in mixed glacial till. Some tills are more local in origin; the soils formed in them reflect the features of the dominant rock that

composes the till. The principal tills of local origin are those dominated by phyllite, in which the Vanzandt, Montborne, Wollard, and Diobsud soils formed and those dominated by dunite, in which the Edfro and Twinsi soils formed.

Most of the tills are dense and compacted at a depth of 2 or 3 feet from the weight and physical processes of the overlying continental ice sheet. Some cementation also occurs (29). The dense till perches water and restricts rooting depth. Steep slopes are generally unstable where the soils are saturated and a sharp discontinuity occurs between the solum and the dense till.

The glacial till and bedrock of the mountains form a complex mosaic, which is often so intricately mixed as to preclude separating the soils formed from these two parent materials. As a result, mapping extensive soil complexes is necessary. These complexes include Kindy-Oso, Saar-Hartnit, Klawatti-Rock outcrop, and Shuksan-Kulshan-Rock outcrop.

Each lithology influences the mineralogy, texture, and available water capacity of the soils involved to different degrees (7). Coarse-textured soils that formed in coarse-textured material, such as sandstone, have a lower available water capacity and lower fertility than the soils that formed in finer-textured material, such as siltstone and phyllite. Most of the soils are modified by eolian deposits that include volcanic ash, probably from Mt. Mazama (12, 27). The incorporation of these deposits and organic matter into the soils dramatically increases the fertility and the available water capacity of the soils (26).

Soils on this unit are moderately deep to very deep and moderately well drained or well drained. The soils at elevations of less than 1,800 feet have an ochric epipedon and a spodic horizon and contain varying amounts of rock fragments. They are mostly Typic Haplorthods and include the Chuckanut, Squalicum, Oakes, and Revel soils.

Soils above 1,800 feet are dominantly Spodosols. Soils between elevations of 1,800 feet and 2,600 feet are Typic Cryorthods. They include the Kindy and Getchell soils. Above 2,600 feet the soils are typically Humic Cryorthods. They include the Shuksan, Potchub, and Gallup soils.

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# Glossary

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**Ablation** till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

**Aeration, soil.** The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

**Aggregate, soil.** Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

**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.

**Alluvium.** Material, such as sand, silt, or clay, deposited on land by streams.

**Animal-unit-month (AUM).** The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

**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.

**Aspect.** Compass orientation of a slope as an inclined elevation of the ground surface.

**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:

Low .....	0 to 3.75
Moderate .....	3.75 to 7.5
High .....	More than 7.5

**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 cross-sectional area of a tree bole measured at 4.5 feet above ground level. It is generally expressed in square feet of cross-sectional area per acre.

**Base saturation.** The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

**Bedding planes.** Fine strata less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

**Bedrock.** The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

**Bisequum.** Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

**Bottom land.** The normal flood plain of a stream, subject to flooding.

**Boulders.** Rock fragments larger than 2 feet (60 centimeters) in diameter.

**Breaks.** The steep or very steep broken land at the border of an upland summit that is dissected by ravines.

**Breast height.** An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

**Brush management.** Use of mechanical, chemical, or biological methods to reduce or eliminate competition of woody vegetation. Control of this vegetation allows understory grasses and forbs to recover or makes conditions favorable for reseeding. It increases forage production and thus reduces the hazard of erosion. Brush management may improve the habitat for some species of wildlife.

**Cable yarding.** A method of moving felled trees to a nearby central area for transport to a processing facility. Most systems involve a drum, a pole, and

wire cables and involve the same principle as that of a rod and reel for fishing. To reduce friction and soil disturbance when the felled trees are yarded or reeled in, one end of the trees generally is lifted completely off the ground or the trees are completely suspended.

- Calcareous soil.** A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.
- Canopy.** The leafy crown of trees or shrubs. (See Crown.)
- Canyon.** A long, deep, narrow, very steep sided valley with high, precipitous walls in an area of high local relief.
- Capillary water.** Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.
- Catena.** A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.
- Cation.** An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.
- Cation-exchange capacity.** The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.
- Channery soil.** A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a chanter.
- Chemical treatment.** Control of unwanted vegetation by use of chemicals.
- Chiseling.** Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control wind erosion.
- Cirque.** Semicircular, concave, bowl like areas that have steep faces primarily resulting from glacial ice and snow abrasion.
- Clay.** As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.
- Clay film.** A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root

channels. Synonyms: clay coating, clay skin.

- Claypan.** A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.
- Clay skin.** A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay film.
- 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.
- Cobbles (or cobblestones).** 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 (7.6 to 25 centimeters) in diameter. The content of these fragments is 35 to 60 percent in very cobbly soil material and more than 60 percent in extremely cobbly soil material.
- Colluvium.** Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.
- Complex slope.** Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.
- 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.
- 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.
- Congeliturbate.** Soil material disturbed by frost action.
- 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.
- Conservation cropping system.** Growing crops in combination with needed cultural and management practices. If soil-improving crops and practices used in the system more than offset the soil-

depleting crops and practices, then it is a good conservation cropping system. Cropping systems are needed on all tilled soils. Examples of soil-improving practices in a conservation cropping system are crop rotations that include grasses and legumes and the return of crop residue to the soil. Other practices include green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

**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.** 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.

**Coprogenous earth (sedimentary peat).** Fecal material deposited in water by aquatic organisms.

**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.

**Cross-slope farming.** Deliberately conducting farming operations on sloping farmland in such a way that

tillage is across the general slope of the land.

**Crown.** The upper part of a tree or shrub, including the living branches and their foliage.

**Culmination of mean annual increment (CMAI).** The average yearly volume growth of a stand of trees from the year of origin to that age which gives the highest average. The CMAI for a particular species is based on the applicable yield table publication and is calculated according to those volumes given for the smallest size.

**Cutbanks cave** (in tables). The walls of excavations tend to cave in or slough.

**Delta.** A body of alluvium that has a nearly flat and fan shaped surface, deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

**Depth to rock** (in tables). Bedrock is too near the surface for the specified use.

**Dip slope.** A slope of the land surface, roughly determined by and approximately conforming with the dip of underlying bedded rock.

**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 for 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 for yields to be reduced.

*Moderately well drained.*-These soils are wet close enough to the surface or long enough for planting or harvesting to be delayed or yields of some field crops to be reduced unless an artificial drainage system 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 for planting or harvesting to be delayed or crop

growth to be markedly restricted unless an artificial drainage system 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. The wetness prevents the growth of important crops (except for rice) unless an artificial drainage system is provided.

**Drainage, surface.** Runoff, or surface flow of water, from an area.

**Duff.** 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.

**Eolian soil material.** Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

**Ephemeral stream.** A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

**Erosion.** The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

*Erosion* (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion. *Erosion* (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature; for example, fire that exposes the surface.

**Erosion hazard rating.** Soils in cultivated areas are rated assuming the soil is bare. Soils in woodland

are rated for the most severe practice on the soils, namely clearcut and burn.

**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.

**Esker** (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

**Excess fines** (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

**Excess salts** (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

**Fast intake** (in tables). The rapid movement of water into the soil.

**Fertility, soil.** The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

**Field moisture capacity.** The moisture content of a soil, expressed as a percentage of the oven-dry 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; generally on the downhill side of the road.

**Fine textured soil.** Sandy clay, silty clay, and clay.

**Firebreaks.** Spaces cleared of flammable material to stop or check creeping of running fires. They also serve as a line from which to facilitate the movement of equipment in fire suppression. Most roads also serve as firebreaks.

**First bottom.** The normal flood plain of a stream, subject to frequent or occasional flooding.

**Flaggy soil material.** Material that is, by volume, 15 to 35 percent flagstones. Very flaggy soil material is 35 to 60 percent flagstones, and extremely flaggy soil material is more than 60 percent flagstones.

**Flagstone.** A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

**Flood plain.** A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

**Fluvial.** Of or pertaining to rivers; produced by river action, as a fluvial plain.

**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.

**Forb.** Any herbaceous plant not a grass or a sedge.

**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.

**Fragipan.** A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

**Frost action** (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

**Genesis, soil.** The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

**Glacial drift** (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

**Glacial outwash** (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

**Glacial till** (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

**Glaciofluvial deposits** (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

**Glaciolacustrine deposits.** Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

**Glaciomarine drift.** Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and rock fragments transported and deposited by floating icebergs in sea water.

**Gleyed soil.** Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

**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 up to 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, up to 3 inches (7.6 centimeters) in diameter.

**Green manure crop** (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

**Ground water** (geology). Water filling all the unblocked pores of underlying material below the water table.

**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.

**Hardpan.** A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

**Head out.** To form a flower head.

**Hemic soil material (mucky peat).** Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

**High-residue crops.** Crops such as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

**Hill.** A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well-defined outline; hillsides generally have slopes of more than 15 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

**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 uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons 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 bedrock beneath the soil. The bedrock 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 capacity.** The maximum rate at which water can infiltrate into a soil under a given set of conditions.

**Infiltration rate.** The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

**Intake rate.** The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2 .....	very low
0.2 to 0.4.....	low
0.4 to 0.75 .....	moderately low
0.75 to 1.25.....	moderate
1.25 to 1.75 .....	moderately high
1.75 to 2.5 .....	high
More than 2.5 .....	very high

**Intermittent stream.** A stream, or reach of a stream, that flows for prolonged periods only when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

**Irrigation.** Application of water to soils to assist in production of crops. Methods of irrigation are:  
*Border.*-Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.  
*Basin.*-Water is applied rapidly to nearly level plains surrounded by levees or dikes.

*Controlled flooding.*-Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

*Corrugation.*-Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

*Drip (or trickle).*-Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

*Furrow.*-Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

*Sprinkler.*-Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

*Subirrigation.*-Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

*Wild flooding.*-Water, released at high points, is allowed to flow onto an area without controlled distribution.

**Kame** (geology). An irregular, short ridge or hill of stratified glacial drift.

**Knoll.** A small, low, rounded hill rising above adjacent landforms.

**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 (7.6 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.

**Light textured soil.** Sand and loamy sand.

**Liquid limit.** The moisture content at which the soil passes from a plastic to a liquid state.

**Loam.** Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

**Loess.** Fine grained material, dominantly of silt-sized particles, deposited by wind.

**Low-residue crops.** Crops such as corn used for silage and peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

**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 of origin to the age under consideration.

**Mechanical treatment.** Use of mechanical equipment for seeding, brush management, and other management practices.

**Medium textured soil.** Very fine sandy loam, loam, silt loam, or silt.

**Metamorphic rock.** Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

**Metasedimentary rock.** Rock that is similar to metamorphic rock but is only slightly altered.

**Mineral soil.** Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

**Minimum tillage.** Only the tillage essential to crop production and prevention of soil damage.

**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.

**Moraine** (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

**Morphology, soil.** The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

**Mottling, soil.** Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance-few, *common*, and *many*; size-fine, *medium*, and *coarse*; and contrast-faint, *distinct*, and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

**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.

**Muck.** Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

**Mudstone.** Sedimentary rock formed by induration of silt and clay in approximately equal amounts.

**Munsell notation.** A designation of color by degrees of three simple variables-hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

**Neutral soil.** A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

**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.

**Observed rooting depth.** Depth to which roots have been observed to penetrate.

**Open space.** A relatively undeveloped green or wooded area provided mainly within an urban area to minimize feelings of congested living.

**Organic matter.** Plant and animal residue in the soil in various stages of decomposition.

**Outwash plain.** A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

**Pan.** A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan*, *fragipan*, *claypan*, *plowpan*, and *traffic pan*.

**Parent material.** The unconsolidated organic and mineral material in which soil forms.

**Peat.** Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

**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.

**Percolation.** The downward movement of water through the soil.

**Percolates 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

**Phase, soil.** A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

**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.

**Plasticity index.** The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

**Plastic limit.** The moisture content at which a soil changes from semisolid to plastic.

**Plateau.** An extensive upland mass with a relatively flat summit area that is considerably elevated (more than 100 meters) above adjacent lowlands and separated from them on one or more sides by escarpments.

**Plowpan.** A compacted layer formed in the soil directly below the plowed layer.

**Ponding.** Standing water on soils in closed depressions. Unless the soils are artificially drained, 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.

**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.

**Potential native 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. (See Climax plant community.)

**Potential rooting depth (effective rooting depth).** Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

**Prescribed burning.** The application of fire to land under such conditions of weather, soil moisture, and time of day as presumably will result in the intensity of heat and spread required to accomplish specific forest management, wildlife, grazing, or fire hazard reduction purposes.

**Productivity, soil.** The capability of a soil for producing a specified plant or sequence of plants under specific management.

**Profile, soil.** A vertical section of the soil extending

through all its horizons and into the parent material.

**Ravel (dry ravel).** Sloughing of weakly cohesive or noncohesive soils, organic material, and rock on steep slopes during dry periods due to gravity.

**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 degrees of acidity or alkalinity, expressed as pH values, are:

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

**Reforestation.** The establishment of planted or naturally occurring tree seedlings in an area that was once forested; also includes the physical acts associated with planting tree seedlings in the ground. The expected period needed for natural reforestation is described by the terms readily, periodically, and infrequently. *Readily* indicates that seedlings are expected to occupy the area in 2 to 5 years; *periodically*, in 5 to 10 years; and *infrequently*, in 10 to 20 years.

**Regolith.** The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

**Relief.** The elevations or inequalities of a land surface, considered collectively.

**Residuum (residual soil material).** Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

**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.

**Rooting depth** (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

**Root zone.** The part of the soil that can be penetrated by plant roots.

**Runoff.** The precipitation discharged into stream

channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called 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-sized particles.

**Sapric soil material (muck).** The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

**Saprolite** (soil science). Unconsolidated residual material underlying the soil and grading to hard bedrock below.

**Scarification.** The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

**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.

**Sequum.** A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

**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.

**Sheet erosion.** The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

**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.

**Silica.** A combination of silicon and oxygen. The mineral form is called quartz.

**Silica-sesquioxide ratio.** The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

**Silt.** As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

**Siltstone.** Sedimentary rock made up of dominantly silt-sized particles.

**Similar soils.** Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

**Site class.** A grouping of site indexes into five to seven 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 show the average heights 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 of age.

**Site curve (100 year).** A set of related curves on a graph that show the average heights 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 of age.

**Site index.** A numerical index equal to the height that dominant or dominant and codominant trees reach at a specific age, usually 50 or 100 years. This index, the age of the stand of trees, and the appropriate yield table publication are used in determining yields.

**Skid trails.** The paths created by skidding logs and the bulldozer or tractor used to pull them.

**Skidding.** A method of moving felled trees to a nearby, central area for transport to a processing facility. Most systems involve pulling the trees with wire cables attached to a bulldozer or rubber-tired tractor. Generally, one end is lifted when the felled trees are skidded or pulled. As a result, friction and surface disturbance are minimized.

**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 60 percent
Very steep .....	60 percent and higher

**Slope** (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

**Slope alluvium.** Sediment gradually transported on mountainsides or hillslopes primarily by alluvial processes and characterized by particle sorting. In a profile sequence, sediments may be distinguished by differences in size or specific gravity of coarse fragments and may be separated by stone lines.

**Slow intake** (in tables). The slow movement of water into the soil.

**Small stones** (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

**Smeary (weakly).** Under moderately strong force between thumb and forefinger, the soil material changes suddenly to fluid, the fingers skid, and the soil smears. This is one of the properties associated with weathered volcanic ash.

**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.

**Stand density.** The degree to which an area is covered with living trees. It is usually expressed in units of basal area per acre, number of trees per acre, or the percentage of ground covered by the tree canopy as if viewed from above.

**Stone line.** A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

**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).

**Stubble mulch.** Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.

**Subsoiling.** Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

**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."

**Tail water.** The water just downstream of a structure.

**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.

**Terrace** (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

**Thin layer** (in tables). Otherwise suitable soil material too thin for the specified use.

**Till plain.** An extensive flat to undulating area underlain by glacial till.

**Tilth, soil.** The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

**Toe slope.** The outermost inclined surface at the base of a hill; part of a foot slope.

**Topsoil.** The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

**Trace elements.** Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, that are in soils in extremely small amounts. They are essential to plant growth.

**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 meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

**Variegation.** Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

**Varve.** A sedimentary layer of a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

**Water bars.** Smooth, shallow ditches or depressional

areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

**Weathering.** All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

**Well graded.** Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

**Wilting point (or permanent wilting point).** The moisture content of soil, on an oven-dry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

**Windthrow hazard.** The likelihood that trees will be blown over by the wind and partially or completely uprooted. The predicted severity of windthrow is described by the terms occasionally and frequently. *Occasionally* means that as much as 5 percent of the trees in a stand may be blown down during periods of excessive wetness and moderate or strong winds. The hazard of windthrow is moderate. *Frequently* means that more than 5 percent of the trees in a stand may be blown down during periods of excessive wetness and moderate or strong winds. The hazard of windthrow is severe.

**Yarding paths.** The paths created by cable-yarded logs as they are pulled up or down a hill to a nearby, central area.

**Yield (woodland).** The volume of wood fiber from harvested trees taken from an area of a certain size. Usually measured in board feet or cubic feet per acre.