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Soils of the Tulameen Area of British Columbia

Report No. 13 British Columbia Soil Survey 1974

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by T.M. Lord and A.J. Green

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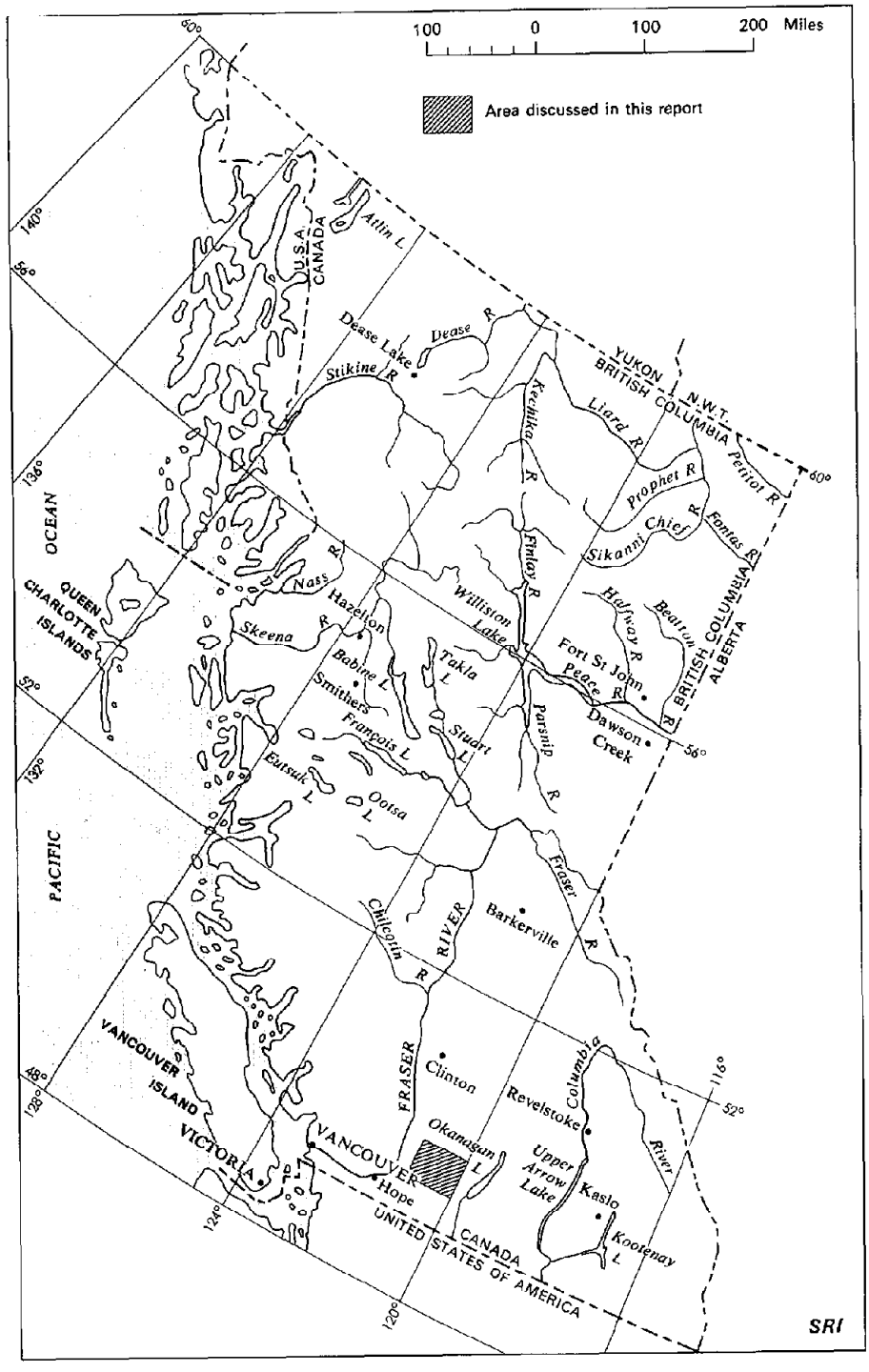


Figure 1. General map of the area covered by the survey.

PREFACE

Soils of the Tulameen Area (92H/NE) is the 13th in a series of reports dealing with soils and soil conditions in British Columbia. The area is located in the plateau region of southern British Columbia (Figure 1). The aim of the reconnaissance survey was to map the soils as precisely as the scale of the map allowed, to show the distribution of the soil units on maps, and to describe the characteristics and limitations of the soils.

Part I describes the location and extent of the surveyed area, the history and development, communications, and natural resources. It describes how the soils were mapped and classified. It locates and describes each mapping unit and its associated soils and shows how the units differ from each other. Other sections evaluate the capabilities of the soils for agriculture, forestry, wildlife, and recreation.

Part II discusses soil development and shows how the soils were classified. A soil key shows relationships between soils. Profile descriptions and analytical data are presented in tabular form. A section describes plant habitat types and a table lists common and scientific names of most plants found in the area.

The soil map, on a scale of 1 inch equals 2 miles, shows the distribution and extent of the soil units. The map legend identifies each soil map unit by color and symbol, the major and minor soil components, its parent material and general landscape characteristics, and the associated vegetation. Topographic phases are shown by symbols and hatching. The report and map supplement one another; therefore, it is necessary to consult both for information about the soils.

ACKNOWLEDGMENTS

Acknowledgement is made to Mr. L. Farstad, Dr. W. A. Ehrlich, and Mr. J. H. Day, Canada Department of Agriculture for advice on classification of the soils and review of the manuscript. Dr. A. Leahey (retired) advised on soil classification and correlation. Dr. Alastair McLean, Research Station, Kamloops, provided the information on vegetation and range ecology; Mr. W. Arlidge of the B.C. Forest Service, Dr. D. Lacate and Mr. M. J. Romaine of Environment Canada supplied data on forest capability. Drs. R. J. Fulton, W. H. Mathews, and L. V. Hills provided geological information and advice. Mr. D. Benn evaluated the area for recreation use. Mr. E. Taylor and Mr. J. Carreiro provided data on waterfowl populations; Mr. D. Blower supplied information on big game. Mr. J. R. Marshall of the Resource Analysis Unit of the E.L.U.C. Secretariat provided valuable information on climate.

The following assisted in field and laboratory work: G. Runka, E. Jagassar, J. Wilson, M. Etter, S. Tzogoeff, R. Bowes, K. James, W. Stanek, R. Muirhead, J. Stobbe, and K. S. Chan.

The soil map was prepared by the Cartography Section, Soil Research Institute, Canada Department of Agriculture, Ottawa.

SUMMARY

The soil survey of the Tulameen area covers about one million acres of land in southern British Columbia. Most of the surveyed area lies in the glaciated Thompson Plateau region and averages 4000 to 5000 feet above sea level. The rolling, dissected uplands of the plateau join the steeply sloping Cascade Mountains, which form the western boundary of the area. Here, some peaks are more than 6500 feet above sea level.

The climate, which is transitional between the West Coast Marine and the southern interior dry belt, is characterized by warm, dry summers and cool, occasionally severe winters.

Stands of ponderosa pine and Douglas-fir, interspersed with open grasslands, cover the lower elevations. At higher elevations, lodgepole pine grows in stands over large areas. Engelmann spruce and subalpine fir dominate the upper forest zone.

Cultivation is confined mainly to the Dark Gray alluvial soils of the main valleys, where pasture and forage crops are produced under irrigation. The ranching industry makes intensive use of the open grassland and semiopen forest range. Well-drained Black and Dark Gray soils developed on till are the dominant soils on the grassland and ponderosa pine – Douglas-fir rangelands. The soils on the forested rangelands are mainly Gray Luvisols.

The main stands of Douglas-fir, ponderosa pine, and Engelmann spruce have been logged off. Engelmann spruce is best suited to the area and is productive on moderately well and imperfectly drained slopes, swales, and valley bottoms. Lodgepole pine is productive on well-drained soils. The soils of the upland forests are Brunisols, Gray Luvisols, and Humo-Ferric Podzols.

Mule deer occur throughout the area. Grouse, waterfowl, and deer are hunted in season. Trout provide good fishing in the many lakes and streams. Recreational activities such as camping, boating, and cottaging are confined mainly to the large lakes and streams of the lower plateau.

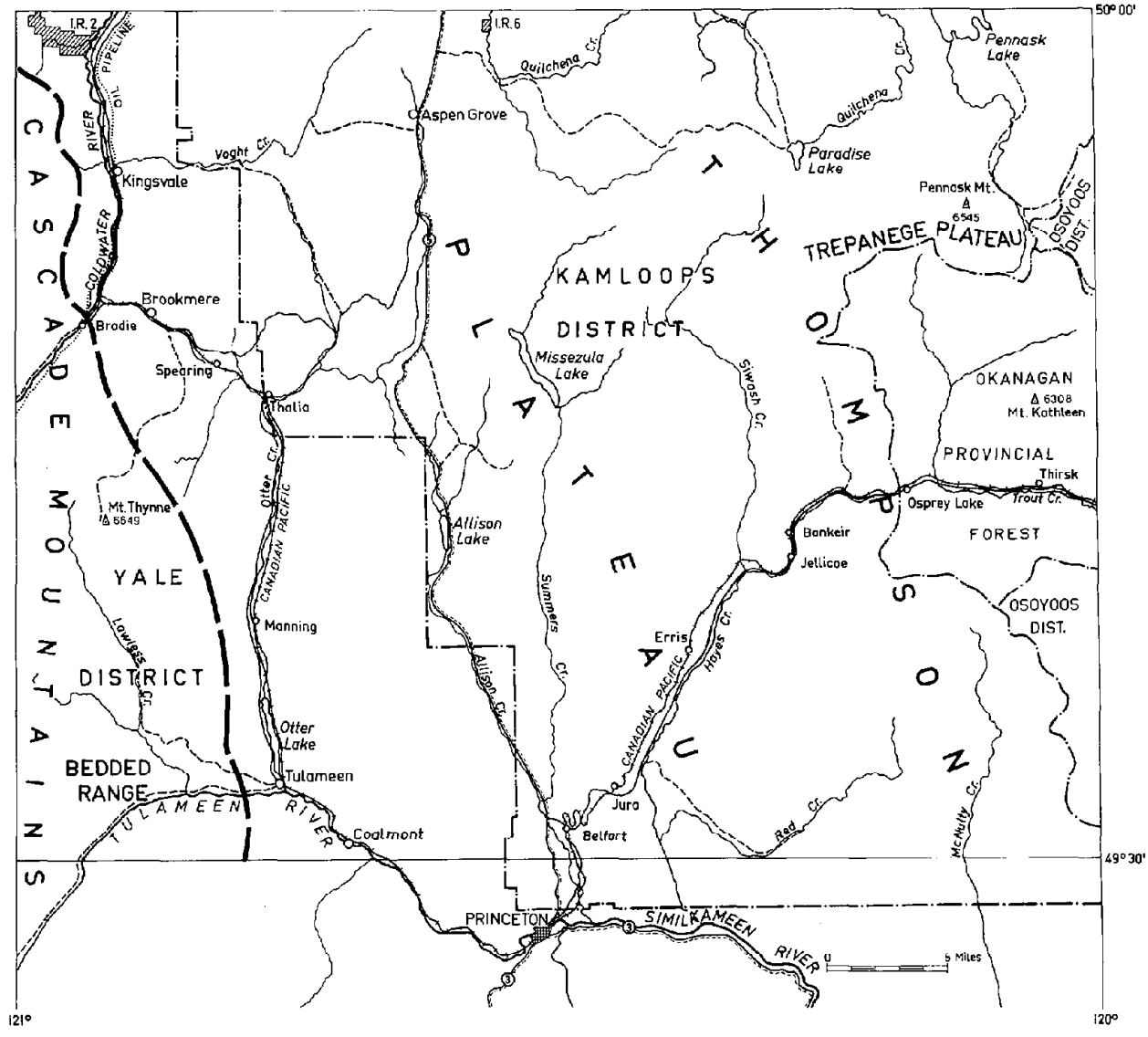


Figure 2. Physiographic divisions, drainage systems, and cultural features of the Tulameen area.

PART I

GENERAL DESCRIPTION OF THE AREA

LOCATION AND EXTENT

The Tulameen area is located almost entirely in the Thompson Plateau region of southwestern British Columbia (Figure 2) and lies between 120° and 121° west longitude and 49°30′ and 50° north latitude. The western boundary approximates the northern limits of the Cascade Mountains. The communities of Coalmont, Tulameen, Brookmere, Kingsvale, and Aspen Grove lie within its borders. The nearest villages are Merritt, 12 miles north, and Princeton, 3 miles south of the area. The surveyed area comprises 990,400 acres.

HISTORY AND DEVELOPMENT

The early settlement and development of south-central British Columbia was based on fur trading and mining and was later influenced by ranching and forestry. In 1813, a fur trader named Alexander Ross was the first man known to have traveled through the Similkameen Valley. After the discovery of gold on the lower Fraser River in the late 1850s, miners and settlers moved through and into the Princeton–Merritt regions. The grassland and alluvial soils were developed for stock raising and farming. Beef cattle and goods were transported by pack train from the interior to Hope when the Dewdney trail was completed in 1865.

About this time, the settlement of Princeton was established and coal was discovered. The discovery of rich placer deposits along the Tulameen and Similkameen rivers and their tributaries in the early 1860s led to the founding in 1885 of Granite Creek, a town that for a few years was the third largest in British Columbia. Several hundreds of thousands of dollars of gold and platinum were produced during about 10 years. Coal has been an important resource of the Coalmont region since the beginning of the century. Copper deposits occur throughout the area. Active exploration and widespread staking of mineral claims are now being carried out.

Although only a few small sawmills operate in the area, harvesting sawlog timber is important to the economy. Douglas-fir is the main tree species, followed by Engelmann spruce and ponderosa pine. Little commercial use has been made of the extensive stands of lodgepole pine, which in terms of total volume for the area are second only to Douglas-fir.

Agriculture is based on beef production on about 225,000 acres of open and semiopen rangeland. Crown range supports about 12,000 cattle and 900 sheep during a 5-month season. The 35,000 acres of irrigated and potentially irrigable soils are used mainly for pasture and field crop production. This arable land, which is limited to major valleys and small, scattered localities, comprises about 3.5% of the area. Organic soils are important sources of wild hay and pasture. Other agricultural activities, such as poultry raising, vegetable growing, and milk production, are limited to supplying local markets.

Linking the villages of Princeton and Merritt, the Canadian Pacific Railway crosses the southern and western parts of the area from the Okanagan Valley through the Trout, Hayes, Tulameen, Otter, and Coldwater river valleys. This rail link, named the Kettle Valley Railway, was completed to Hope in 1915. In 1961, the Coquihalla rail line to Hope was abandoned. Present rail connections to Vancouver are by a line through Merritt to Spences Bridge and by the main Canadian Pacific Railway line through the Fraser Canyon. Passenger service was discontinued in 1963.

Highway 5, a two-lane hard-surface road, runs north from Highway 3 at Princeton to Merritt and Kamloops. Local public, logging, range, and telecommunication roads traverse most of the valleys and provide limited access to the higher plateau.

No airfields or airports are located in the area, but Princeton and Merritt have alternate or emergency air fields. Electric power and telephone services are supplied through Princeton to most communities; all other services, such as medical, library, and higher educational facilities, are located outside the area.

Tourist facilities are centered mainly at Princeton and Merritt. Many lakes in the valleys and plateaus are stocked with trout and provide good fishing. Deer, elk, moose, bear, grouse, and waterfowl are hunted in season. Many lakefront and riverside properties are being developed as summer resorts (Figure 3).

CLIMATE

The climate of the area is transitional between the Marine West Coast and the southern interior dry belt. Climatic data from stations at Allison Pass, Princeton, Osprey Lake, Merritt, and Mamit Lake (Tables 1 and 2) show the influence of moist maritime air that moves through the deep valleys and over the lower parts of the Coastal Range and the Cascade Mountains.

Allison Pass is located in a deep, east- to west-trending valley of the Cascade Mountains about 25 miles south of

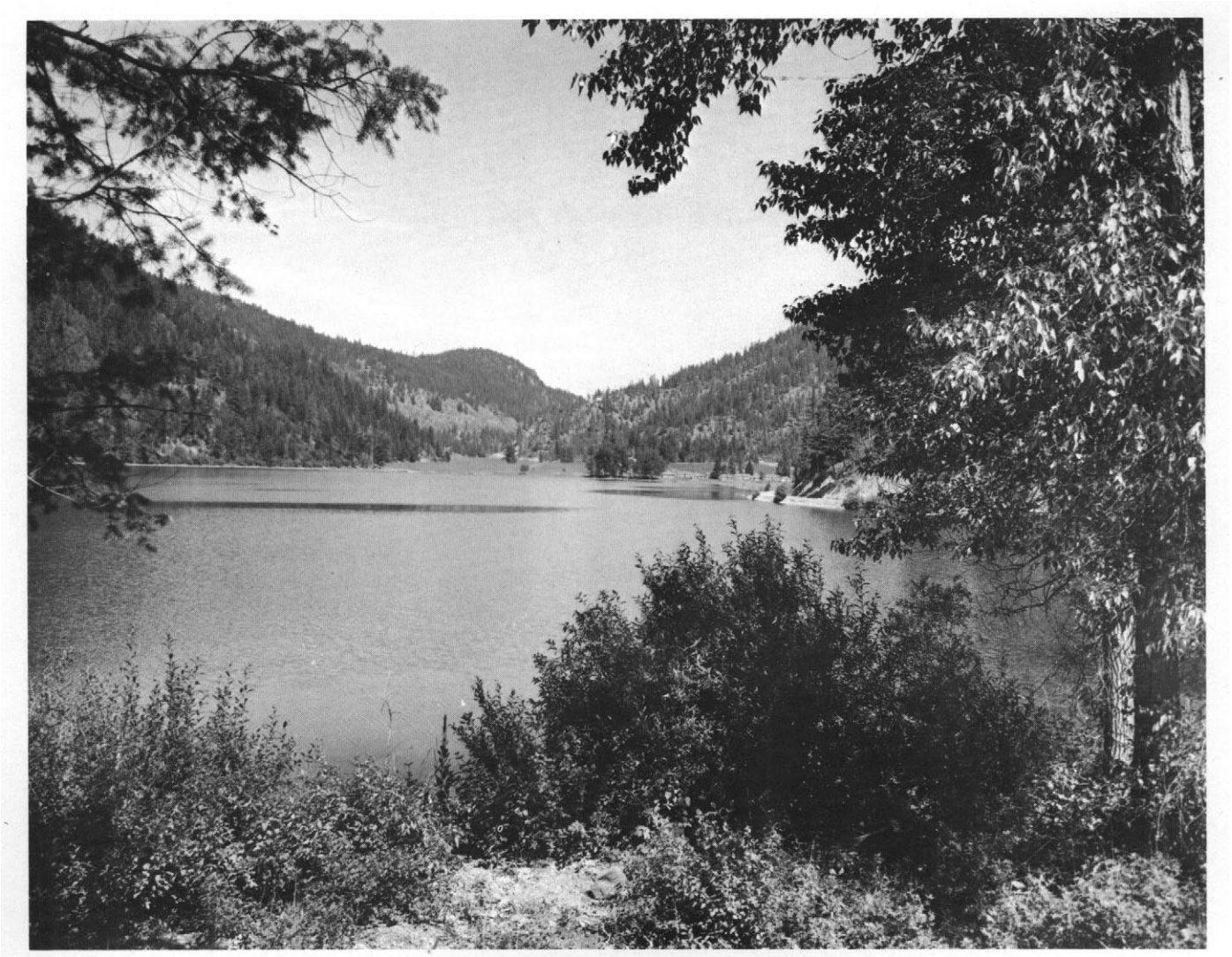


Figure 3. Allison Lake, 18 miles north of Princeton. Intensive recreational use combined with farming on coarse textured soils of shoreline, alluvial fan deposits (British Columbia Government photograph).

the area near the transition from mountains to interior uplands. Here, high snowfall is characteristic in winter. At Princeton Airport, which is 15 miles to the east and about 2000 feet lower in elevation, precipitation is only one-quarter that of Allison Pass. At Princeton, winters are cold and cloudy, summers are warm with cool nights, and precipitation is light and fairly evenly distributed.

In some years, polar air flows southward through north- to south-oriented valleys or flows into the area by way of mountain passes from Alberta. The ground is snow covered most of the winter. Snowfall is 30 to 50 inches in valley bottoms and 80 to 150 inches on west slopes and crests of the uplands.

In the valleys and other elevations below about 4000 feet, the total precipitation is 13 to 21 inches and the mean annual temperatures average 38° F to 42° F. Below this elevation there are 1650 to more than 2150 growing degree-days, and the growing season is 183 to 195 days. Inversion frosts in dry valleys can be severe, especially on low ground that has poor air drainage. The frost-free period varies from 60 to 102 days. In the high plateau and mountains, available climatic data indicate less than 1200 degree-days and a frost-free period of less than 50 days.

June is generally cloudy with frequent rain. Over half the rainfall occurs from May to September. Princeton and Merritt have a water deficiency of up to 8 inches in an average year. Excess moisture increases at higher elevations and near the mountains. Showers or thunderstorms are the main summer precipitation.

North of the area, at Merritt and Mamit Lake, the climate (Tables 1 and 2) is similar to that of Princeton. Osprey Lake station is in a deep valley east of Princeton and near the boundary of the area. Although the frost-free periods, number of degree-days, and temperature ranges are similar, the growing season is shorter and wetter (Tables 1 and 2).

Table 1. Mean monthly temperatures and total precipitation at selected stations*

	OSPREY LAKE 3600 ft.		PRINCETON AIRPORT 2283 ft.		MERRITT 1930 ft.		MAMIT LAKE 3215 ft.		ALLISON PASS 4400 ft.	
	Mean temp. °F	Total pptn. inches	Mean temp. °F	Total pptn. inches	Mean temp. °F	Total pptn. inches	Mean temp. °F	Total pptn. inches	Mean temp. °F	Total pptn. inches
Jan.	16	2.9	18	2.88	19	2.43	13	1.20	18	10.76
Feb.	21	2.3	31	0.40	32	0.41	22	0.9	27	2.32
March	28	1.6	34	0.53	37	0.95	27	0.9	26	3.49
April	39	1.0	41	0.38	42	0.32	39	0.6	29	5.66
May	49	1.2	51	0.08	52	0.26	48	1.2	41	1.15
June	53	1.9	64	0.59	64	0.34	53	1.6	52	1.30
July	59	1.3	66	0.47	67	0.13	59	1.0	55	0.26
Aug.	56	1.3	66	0.08	65	1.05	57	1.3	54	0.48
Sept.	51	1.2	52	1.01	52	0.37	50	1.2	43	2.77
Oct.	40	1.7	42	1.25	44	0.27	40	0.9	34	3.08
Nov.	27	2.1	28	1.91	28	2.38	29	1.1	23	6.46
Dec.	21	3.2	18	1.74	20	2.05	22	1.4	18	11.49
Year	38	21.7	43	11.32	44	10.96	38	13.3	35	49.22
Winter snow, inches			65.6		30.3				320.5	
Years observed	24		32		41		30		12	

*Climate of British Columbia—B.C. Department of Agriculture; Report for 1970

Table 2. Durations and dates of growing season, degree-days, precipitation, temperature, water deficiency and surplus, and frost data during the growing season at selected stations in or near the area

	OSPREY LAKE	PRINCETON AIRPORT	MERRITT	MAMIT LAKE	ALLISON PASS
Growing season, 42° F					
beginning	April 25	April 10	April 14	April 26	
end	Oct. 25	Oct. 22	Oct. 22	Oct. 10	
duration, days	183	195	201	198	
precipitation, inches	7.1	5.0	3.6	6.3	
average maximum temperature, °F	66.3	70.0	68.2	65.4	
degree-days	1810	2604	2728	1768	
Average date of last frost in spring	June 15	June 1	June 1	June 19	June 15
Average date of first frost in fall	Aug. 15	Sept. 1	Sept. 15	Sept. 8	Aug. 15
Frost-free period (32° F), days	62	88	118	81	60
Moisture surplus	6.8	1.8	0.0	0.1	20.3
Moisture deficit	4.5	9.6	13.9	6.7	3.9

PHYSIOGRAPHY AND DRAINAGE

The general relief and drainage systems are shown in Figure 2. The area lies almost entirely in the Thompson Plateau, a subdivision of the Southern Plateau and Mountain Area of the Canadian Cordillera (Holland 1964). To the west and southwest the plateau merges with the Hozameen Range of the Cascade Mountains. Low to moderate relief characterizes the rolling upland in this part of the Thompson Plateau. The average elevation is 4000 to 5000 feet, with minimum elevations of 2300 feet in the Coldwater and Tulameen river valleys. Local peaks that rise above the Tertiary erosion surface are Mount Thynne (6649 feet), Pennask Mountain (6545 feet), and Mount Kathleen (6308 feet).

The main drainage is southerly, through the deeply incised valleys of the tributaries of the Similkameen River, which include the Tulameen River and Otter, Allison, Summers, and Hayes creeks. Along the eastern boundary of the area, Trout and Peachland creeks flow easterly into Okanagan Lake to join the Columbia River system. The Coldwater River and Quilchena Creek drain northward into the Nicola River, a tributary of the Fraser system. The many medium- and small-sized lakes are found mainly in the northern part of the area. The large lakes are deep, narrow, and generally oriented north to south. There is evidence that a former strongly developed east-to-west drainage system has been disrupted by alteration in stream volumes and changes in direction, and by valley filling resulting from glacial action (Mathews 1944).

VEGETATION

The lower parts of the Thompson Plateau lie in the Ponderosa Pine and Douglas-fir sections of the Montane Forest Region, and the higher elevations of the plateau and the mountain transition zone are in the Interior Subalpine Section of the Subalpine Forest Region (Rowe 1959).

The drier parts of the Princeton basin and northern valleys at the lowest elevations of the plateau have stands of ponderosa pine and occasional Douglas-fir associated with grasses and forbs of the grasslands. Characteristic plants are bluebunch wheat grass, Idaho fescue, needle grasses, tall white eriogonum, pasture sage, and silky lupine. Trembling aspen commonly grows in moist draws. Douglas-fir and lodgepole pine form a fairly dense canopy over an understory of bearberry, arnica, twinflower, and pine grass.

The Interior Subalpine Section occupies higher elevations in the Hozameen Range and Trepanege Plateau. Engelmann spruce, subalpine fir, and lodgepole pine, which occur in dense mixed stands, are the main tree species. The ground cover includes red alpine blueberry, pine grass, twinflower, black huckleberry, false-box, wintergreen, and arnica. Near the tree line, at about 6800 feet, trees are stunted and scattered in an open parkland. Blueberries, false-heathers, arnica, mountain valerian, sedges, and grasses dominate the herbaceous vegetation.

GEOLOGY AND PARENT MATERIALS OF THE SOILS

The area is underlain by Paleozoic to late Tertiary volcanic rocks that are interbedded in small amounts with sedimentary rocks, and by granitic intrusive rocks of Jurassic to late Cretaceous or early Tertiary age (Rice 1960).

During the Pleistocene epoch, continental ice sheets covered most of British Columbia to altitudes of over 8600 feet (Rice 1960). The last ice sheet in the area moved southward, mainly along a broad channel between the Otter and Siwash valleys (Mathews 1944). Drumlinoid ridges composed of glacial till record the ice movement. These ridges, with their intervening grooves oriented southerly and southeasterly, occur mainly in the Pennask Lake and Aspen Grove vicinities.

As the stagnant ice retreated to the uplands, successive meltwater channels were cut into the plateau slopes (Fulton 1967). Maximum erosion of the till was accompanied by sorting of meltwater deposits.

Morainal deposits cover most of the area. Generally, glacial tills reflect the characteristics of the underlying bedrock. Tills influenced by lavas, tuffs, and argillites of the Nicola formation, together with Tertiary rocks of the Princeton group, are deep, moderately coarse to moderately fine textured, and slightly alkaline. The main soil units developed on these materials are Brenda, Connaly, Grant, Mazama, and Princeton. Breccias, andesites, and basalt porphyrys of the Kingsvale and Spence Bridge groups are the main components of the moderately fine textured, reddish tills on which Britton soils have developed. A moderately alkaline, moderately fine textured till, derived chiefly from Tertiary Coldwater shales, is the parent material of Fairweather soils. Morainal deposits associated with Coast Intrusion granodiorites are generally shallow, coarse textured, and acidic to neutral. These undivided till and colluvial materials are the parent materials of Alleyne, Bonnevier, Lawless, Tulameen, and Wilbert soils.

Some lacustrine and glaciolacustrine deposits occur in the northern part of the area. Howarth and Midday soils have developed on stratified silty lacustrine deposits in the valleys of Quilchena Creek and the Coldwater River. Silts and fine sands deposited in ponding areas of stream valleys are the parent materials of Eastmere soils.

Glacial meltwaters eroded the plastic, saturated till of the uplands and carried the fines into the valleys and depressions. Part of the coarse residue from the erosion of the till was deposited over the uplands in the form of kettled terraces, deltas, ice marginal terraces, eskers, and kames. Asp, Galena, Henning, Pasayten, and Trehearne soils developed on these materials.

Recent stream channel and floodplain deposits vary in texture and drainage. Bluey, Iltcoola, Manning, and Riddell soils occur on these materials. Fan deposits, which occur in a few places in the surveyed area, are the parent materials of Thalia soils.

Organic deposits, represented by Coley and Etches soils, are developed on intermediately decomposed peaty materials.

THE SOILS

This section deals with some of the more fundamental soil characteristics and properties that are important to the user. It describes how the soils were mapped, described, and classified. It shows how the basic units, the soil series and land types, are related and grouped together to form map units. The distribution of these map units is shown on the soil map.

Field work involved traveling all roads and trails by motor vehicle. Inaccessible areas were checked by helicopter. Soils were examined and described in soil pits and road cuts, and notes on topography, vegetation, and other physical features were recorded on field sheets and on air photos. Air photo interpretation was used extensively in preliminary studies of physical features and was a basic aid in plotting the boundaries between map units. Boundaries, symbols of map units, and topography were transferred to large-scale base maps for final compilation of the published map at a scale of 1 inch equals 2 miles.

The detail and reliability of mapping vary in different sections of the area. Detailed and semidetailed reconnaissance surveys were conducted in the main valleys and adjoining plateau lowlands. Because the composition of each map unit in these sections was known, boundaries between units could be accurately drawn. In the uplands and mountainous sections, where traverses were limited to occasional roads, trails, and helicopter drops, the boundaries of the map units were plotted at intervals and then projected by air photo interpretation. The percentage composition of each map unit was estimated on air photos using field note records.

The description of a soil involves the study of the parallel layers, or *horizons*, that have developed through soil-forming processes. Such a sequence from the surface into unweathered soil material is called a *soil profile* and is exposed in road cuts or soil pits. Horizons consist of organic layers, designated as O or L–F–H, and master mineral horizons or layers, designated A, B, C, and R. (Figure 4). These horizons and subhorizons are fully described in the Glossary.

Important features of the horizons are color, texture, structure, consistence, and reaction. *Color* is an easily determined and important feature for soil identification. The range and kinds of color in soil horizons are usually good indications of organic matter content, drainage, aeration, iron content, and leaching effects. Imperfectly and poorly drained soils are usually mottled with shades of gray, brown, and yellow.

Soil *texture* refers to the proportions of clay, silt, and sand less than 2 millimeters in diameter. When coarser soil particles constitute 20% to 50% of the soil volume, the terms gravelly or cobbly are used. For example, a gravelly loam has 7% to 27% clay, 28% to 50% silt, less than 52% sand, and more than 15% coarse particles. Although the texture of a horizon may be modified by plowing or by the addition of new material, texture is considered to be the most stable feature of a soil.

Soil *structure* is the most important characteristic of the soil profile that influences plant growth. The form, size, and durability of the soil aggregates determine pore space, moisture-holding capacity, and distribution of plant roots within the soil mass. A soil horizon may have platy, blocky, spheroidal, or columnar structure, or it may be nonaggregated, that is, structureless.

Soil *consistence* is closely allied with texture and refers to the attractive forces between soil particles. Depending on texture and moisture condition, soils may be loose and friable, firm, sticky, plastic, or cemented. A heavy textured soil generally becomes sticky and plastic when saturated.

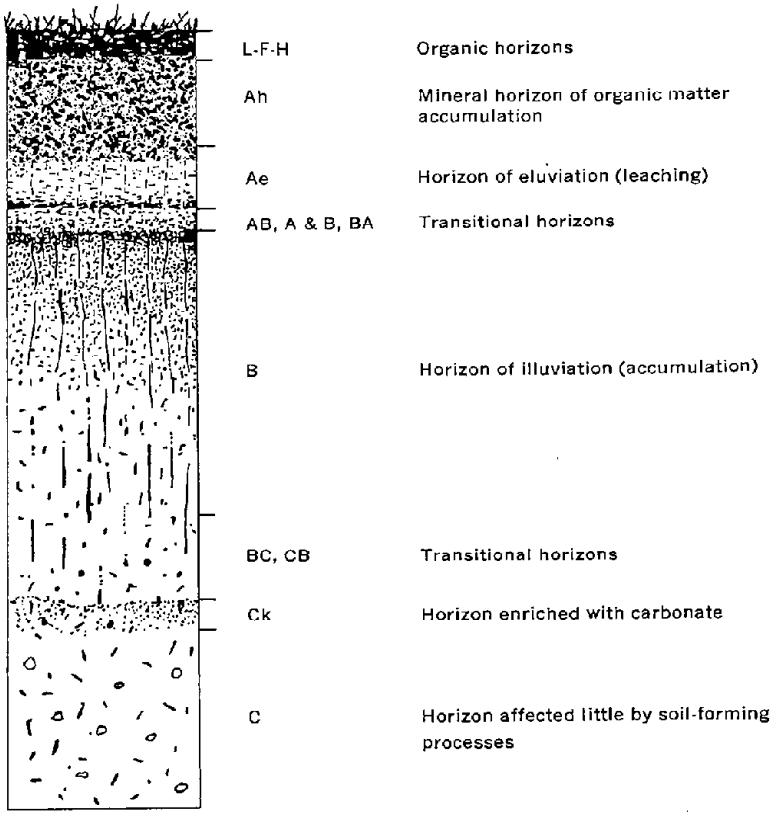


Figure 4. Common horizons in a soil profile. Some profiles may not have all these horizons clearly developed. The mineral horizons are denoted by lowercase suffixes, for example h, e, and k, the suffix depending on the distinctive feature of the layer.

In this state it is hard to work with machinery or it may flow down unprotected slopes causing gully or sheet erosion.

Reaction classes, which range from extremely acid (pH 4.5) through neutral (pH 6.6–7.3) to very strongly alkaline (pH 9.0), are important guides in identifying and classifying soils. The intensity of soil acidity or alkalinity is an indication of the base status or the ability of a soil to retain plant nutrients. Most plant crops grow best within the slightly acid to neutral reaction range. Native plants seem to have a much wider soil pH tolerance than cultivated crops.

Additional features, some of which do not occur in all horizons, are: thickness range; distinctness and form of the lower horizon boundaries; the abundance, size, and distribution of roots and pores; the frequency, thickness, and location of clay films; the presence of salts; and the size and abundance of stones. External features important to soil usage are landforms, topography, soil drainage, and erosion.

The soils of the Tulameen area are grouped according to kinds of parent material (Table 5). Soils that are developed from parent materials similar in texture and mineralogical composition, and that have profiles with a similar number and arrangement of horizons whose chief characteristics are within a defined range, belong to the same *soil series*. The range of profile features, such as color, texture, and structure, is narrow enough to differentiate between series, but is wide enough to allow a series to be identified in the field and delineated on a map. If a soil series name is used as a map unit, the series may include up to 15% of other units.

The soil series form the basic structure of the *soil catena,* the chief map unit of the Tulameen area. A catena is a group of soils, usually of strongly contrasting profile features, that develops from similar parent materials under a range of relief and drainage conditions. A *soil complex* is a map unit that comprises two or more defined units that occur together in an intricate pattern. Two land types, Rock Outcrop and Steeplands, were established as map units. Each soil catena or complex is identified by the major soil series that comprises about 60% or more of the unit. In the Tulameen area, several map units were divided into subunits on the basis of proportions and kinds of other soils present.

According to *The System of Soil Classification for Canada* (1974), soil series are classified into subgroups, great groups, and orders. Thus, the Princeton catena is a map unit in which the major soil is the Princeton series. The Princeton series belongs to the Orthic Black subgroup of the Black great group, a subdivision of the Chernozemic order. In the Princeton catena, the Princeton series occupies the mid-slope positions that have medium runoff; the Miner series occurs on ridge crests that have very rapid runoff and are more subject to erosion; and the Collett series occupies nearly level depressions that receive additional water from higher slopes. Runoff is very slow and there is no erosion. The Separation series, which occupies an intermediate position between Princeton and Collett, has moderate runoff.

Part I of the report contains nontechnical descriptions of the soils and map units. The users of the report can identify the soils in the field and relate them to other soils and to the environment. Technical descriptions of soil series and analytical data are given alphabetically in Part II of the report. Soil formation, the factors of soil development, and classification are discussed in Part II.

SOILS ON MORAINAL DEPOSITS

In the Tulameen area, soils developed on till and colluvial deposits occur extensively in the plateau and mountains and occupy about 82% of the area. Luvisolic, Brunisolic, Chernozemic, and Podzolic soils predominate. The soil map units include Brenda, Britton, Connaly, Fairweather, Grant, Mazama, and Princeton, which have developed on glacial till, and Alleyne, Bonnevier, Lawless, Tulameen, and Wilbert, which have developed on undivided till and colluvial deposits. These map units were delineated largely by air photo interpretation.

GLACIAL TILL

The Brenda, Britton, Fairweather, and Princeton catenas have developed on mildly alkaline loams to clay loams on strongly drumlinized till plains. Although some large drumlins are composed of thick till, the thickness ranges from a fraction of a foot to about 10 feet. The parent materials of the Connaly, Grant, and Mazama soil units are slightly acid sandy loams and loams. Landforms associated with these materials are a series of elongated ridges and troughs that have a fluted topography of low relief.

The Brenda Map Unit

The Brenda catena consists chiefly of Chernozemic soils developed on brownish loam till. The catena is confined mainly to transitional grassland–forest sections, which occur in the upper Otter Valley and northeastward from Aspen Grove. These soils occupy about 8800 acres.

The parent materials of these soils are medium and moderately fine textured, neutral or mildly alkaline tills. Large, elongated ridges up to 0.5 mile long are the main landforms. The topography is strongly to steeply sloping. The elevation of the catena is 3500 to 4000 feet above sea level. The typical vegetation is an open forest interspersed with grasslands. The main tree species are ponderosa pine, trembling aspen, and Douglas-fir; bunch grasses, forbs, and shrubs form the ground cover.

The *Brenda* catena consists of Orthic Dark Gray soils that occupy smooth, steep side slopes and drumlins and low ridges. They are well drained and moderately permeable. A semiopen forest dominated by ponderosa pine and trembling aspen with bunch grass ground cover forms

the vegetation. The profile has a 2-inch organic surface layer (L–F–H), a thin, very dark brown loam (Ah), and 8 to 10 inches of dark gray horizon (Ahe). The brown loam (Bm) overlies a transitional horizon (BC) over calcareous till (Ck) at about 30 inches.

The Collett series, a Carbonated Rego Dark Gray soil of the Princeton catena, occupies imperfectly drained depressions and drainageways between drumlin ridges.

The Brenda soils are commonly associated with the Connaly and Princeton series.

The soils of the Brenda catena are limited for agricultural use because of steep irregular slopes. As summer range for cattle, these soils have an average carrying capacity of 5 to 7 acres per animal–unit–month (AUM). Deer use the areas for summer forage and as wintering ranges. There are no trees of commercial value on the Princeton and Collett soils.

The Brenda soils have a low forest capability, mainly because of aridity. The annual growth of ponderosa pine is less than 30 cubic feet of wood per acre.

Open stands of mature ponderosa pine near resort areas can be valuable for recreation.

One map unit was recognized in the area.

Brenda (BD)

This map unit contains more than 60% Brenda series. The Princeton and Collett series may each occupy about 20% of the unit. The units occur near Aspen Grove and provide valuable spring and fall grazing for cattle and mule deer. Soils of the unit have little commercial value for timber, but the typical open stands of mature ponderosa pine have aesthetic values for recreation. About 8800 acres were mapped.

The Britton Map Unit

The soils of the Britton catena predominate in the part of the area west of Otter Valley. These soils have developed on moderately fine textured, mildly alkaline till. The catena covers about 82,000 acres at elevations of 3400 to 5700 feet.

The topography is moderately to steeply sloping on the drumlinized till plain. Douglas-fir and lodgepole pine form a fairly dense canopy, associated with a pine grass understory. Subalpine fir, lodgepole pine, and Engelmann spruce occur at upper elevations, whereas ponderosa pine and Douglas-fir occur on lower slopes.

The Britton catena contains the soils of the Britton (Orthic Gray Luvisol), Selish (Lithic Gray Luvisol), and Coalmont (Orthic Dark Gray) series.

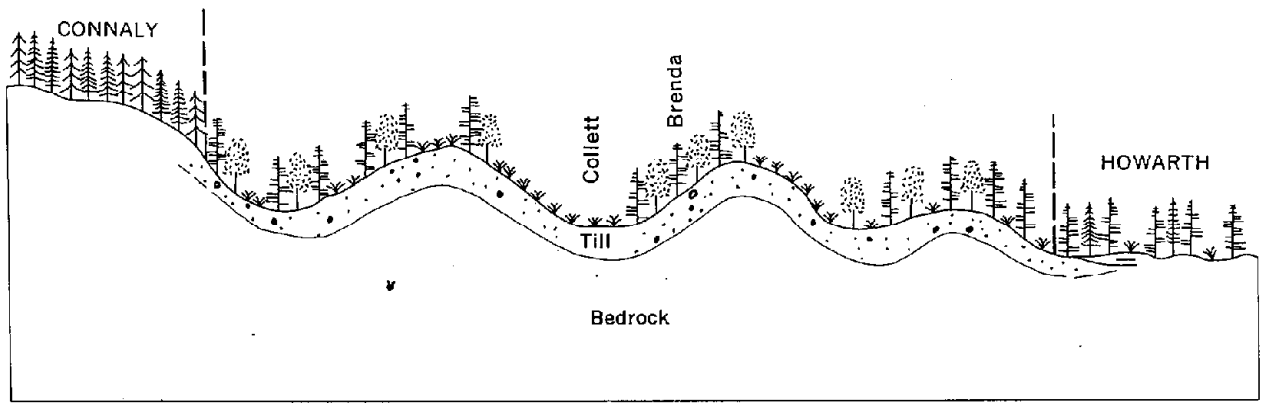
Britton is the dominant series. The soils of this series are well drained with thin litter horizons (L–F), grayish brown sandy loam and loam (Ahe, Ae) over pinkish gray clay loam (Bt), and a calcareous horizon (Ck) at 30 to 50 inches. Britton soils occur on gently to strongly sloping topography. They are moderately to slowly permeable with slow surface runoff. Loam is the main soil texture. The main trees are Douglas-fir and lodgepole pine over pine grass ground cover.

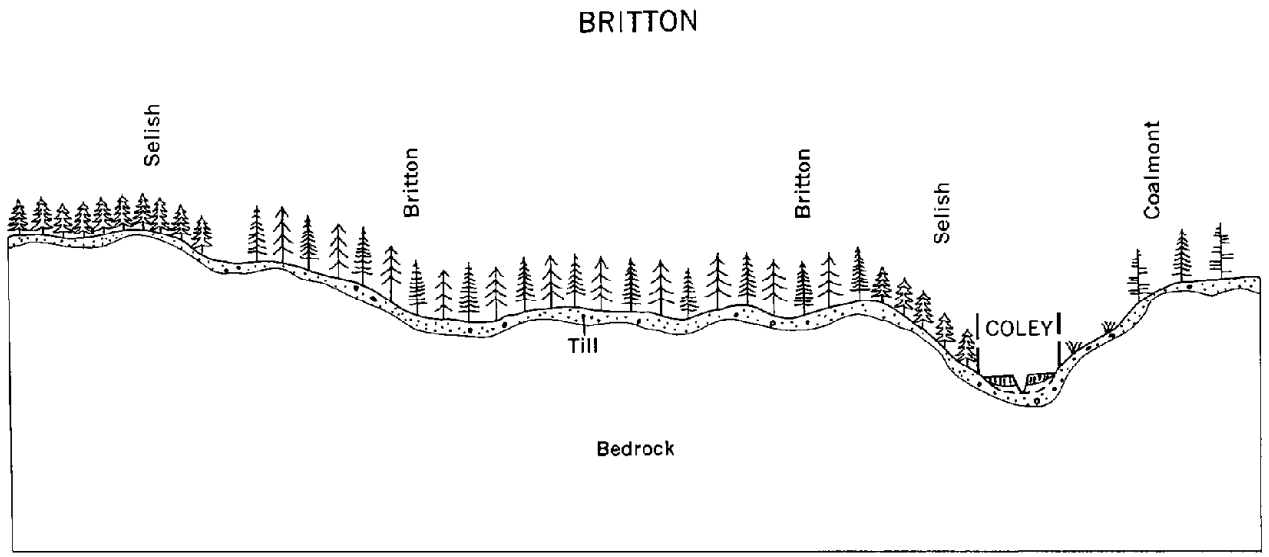
Britton soils are associated with the Connaly soil series and the Rock Outcrop land type in the uplands adjoining the Coldwater and Otter river valleys. Britton soils differ from Connaly soils in their distinct reddish soil horizons. Some Brunisolic Gray Luvisol soils occur at high elevations.

Selish soils occupy steep, eroded ridges, where the mantle of till or colluvium is shallow over bedrock. These well-drained soils have reddish brown loam horizons (Ae, BtC) that overlie rock (R) at depths of 4 to 20 inches below the surface. Selish soils closely resemble the Kane series. A canopy of lodgepole pine, subalpine fir, and Engelmann spruce over a ground cover of shrubs and forbs make up the native vegetation.

Coalmont soils occur on smooth, steep, south and west aspects of valley sides and drumlin slopes. Under a semi-open cover of Douglas-fir, ponderosa pine, trembling aspen, and bunch grasses, the soil profile has a dark surface horizon (Ahe) 6 to 8 inches thick over reddish brown subsoil (Bt, C).

BRENDA





On suitable topography, Britton soils can be used to grow some forage crops. Most of the soils are used only for permanent pasture because they occur on irregular, steep slopes. Adverse topography, droughtiness, and stoniness restrict soils of the Coalmont and Selish series to use for forage production or native pasture.

Britton soils are limited mainly by soil moisture deficiency and produce less than 70 cubic feet per acre per year of Douglas-fir and lodgepole pine. Lodgepole pine that grows on the lithic Selish soils is restricted to an annual growth rate of 30 to 50 cubic feet per acre. A similar range for Douglas-fir and ponderosa pine occurs on Coalmont soils.

Two map units occur in the area.

Britton 1 (BT 1)

This unit contains about 70% Britton series and 30% Selish. On the higher elevations, Selish soils may occupy 40% to 50% of the unit. The proportions of Rock Outcrop generally increase with elevation. The map unit occupies most of the northwestern part of the area. The soils are used by livestock and mule deer as summer range. The logging of Douglas-fir and Engelmann spruce is a primary use. About 62,300 acres were mapped.

Britton 2 (BT 2)

About 60% of this unit is Britton series and 40% is Coalmont series, Rock Outcrop, and minor inclusions of Black Chernozemic soils. The unit is confined to steep, southerly slopes along the Kane Valley and bordering the Boss Lake valley. Present use is almost exclusively grazing by livestock and mule deer. About 19,700 acres were mapped.

The Connaly Map Unit

The Connaly catena consists mainly of Gray Luvisol soils. The catena occupies most of the lower plateau adjoining the grasslands near Aspen Grove and Princeton. The soils of the catena occur on moderately coarse and medium textured, slightly acid to neutral till. They cover about 131,000 acres.

The soils occur on moderately to steeply sloping topography on a drumlinized till plain. Some areas of irregular hummocky land occur. Elevations range from 3200 to 4400 feet. The native vegetation consists mainly of a moderately dense forest of Douglas-fir and lodgepole pine over a pine grass understory. Patches of open forest containing bunch grasses and a variety of forbs occur only on south- and west-facing slopes.

The Connaly catena consists of the Connaly (Orthic Gray Luvisol) and Kane (Lithic Gray Luvisol) soil series.

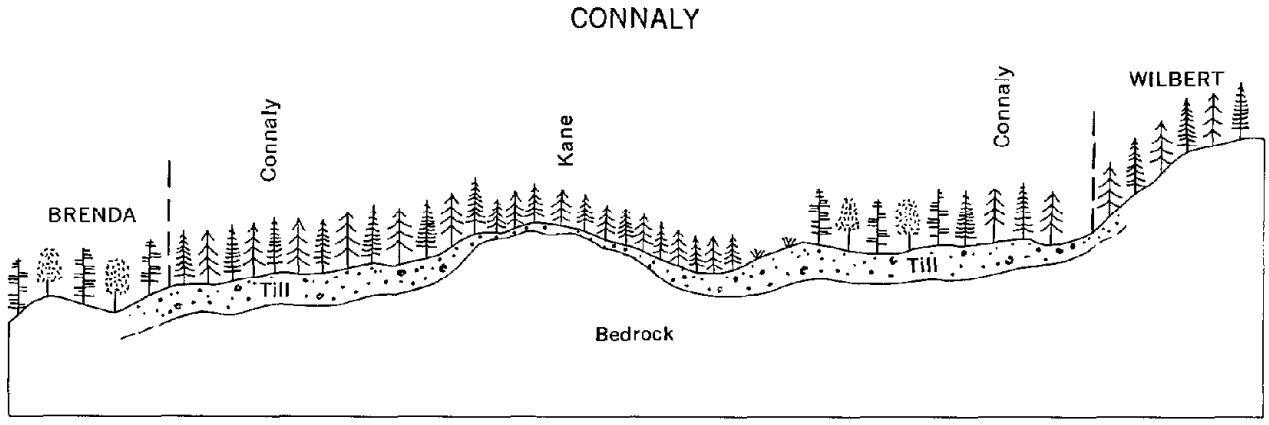
Connaly is the dominant series. The soils of this series are well drained and are characterized by moderate surface runoff and moderate permeability. The topography is gently to moderately sloping. Douglas-fir and lodgepole pine make up the upper story, and pine grass, kinnikinnick, arnica, and twinflower dominate the ground cover. Loam is the predominant soil texture but there are some areas of sandy loam and fine sandy loam.

The Connaly series is associated with Britton soils in the Coldwater and Otter valleys. Britton soils are distinguished by reddish brown profiles derived from weathered volcanic formations.

Connaly soils occur with soils of the Bankeir series and with Rock Outcrop on abraded ridges and knolls, and with soils of the Tulameen and Alleyne series in complexes of till and colluvial deposits.

Connaly soils have a thin litter layer (L–F) over brownish gray loam (Ae) 8 to 10 inches thick, and transitional horizons (BA). A grayish brown sandy clay loam (Bt) overlies calcareous loam (Ck) at 44 inches.

Kane soils occur on eroded, convex upper ridge crests and knolls. These glacially abraded ridges are thinly mantled with till and colluvium. Kane soils are well to



rapidly drained and have a low moisture-holding capacity. They have organic litter layers (L–F–H) over brown loam (BA, Bt) that has an abrupt boundary on rock (R) within 4 to 20 inches of the surface. The Kane series resembles the lithic Selish series, but lacks the strong colors of the Selish soils (Figure 5).

The Brenda series often occurs with Connaly soils on steep south- and west-facing slopes.

Connaly soils can produce perennial forage crops, but very little land is cultivated at present. Topography is the main limitation. These soils, which include the Kane series, are used as unimproved native pasture and have an average carrying capacity of 7 or more acres per animal–unit–month.

Forest productivity for Douglas-fir and ponderosa pine on Connaly soils averages 50 to 90 cubic feet per acre annually. On Kane soils, soil moisture deficiency and restriction of the rooting zone by bedrock limit the annual growth of lodgepole pine and Douglas-fir to less than 50 cubic feet of wood per acre.

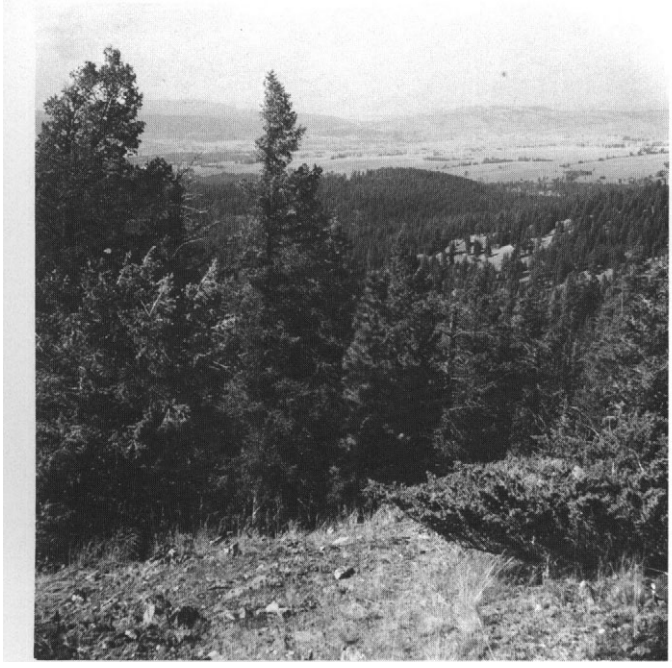


Figure 5. Connaly catena in foreground: Kane series, a Lithic Gray Luvisol, with exposed bedrock. The open grasslands of the Fairweather catena are in the background.

Wildlife, particularly mule deer, use the lower slopes composed of Connaly soils as winter range. The Kane series supports summer range for deer.

Two map units were established.

Connaly 1 (CN 1)

This unit contains 70% Connaly series and 30% Kane series. Small amounts of Gleyed Gray Luvisol and Dark Gray soils are present. This unit is found on moderately to strongly sloping drumlinized topography. The soils have limited capability for crop production, but they provide valuable native pasture. Wildlife make extensive use of these soils for summer grazing and winter habitat. The logging of Douglas-fir is a major use on sites of these soils. About 116,000 acres were mapped.

Connaly 2 (CN 2)

These units are located near the Otter River valley and Aspen Grove. They contain 60% Connaly and 40% Brenda series. The topography is strongly to steeply sloping. In general, the slope aspects are southerly or westerly. The Brenda soils provide early spring and summer grazing for livestock and deer. Timber harvesting is confined to selective logging of Douglas-fir, lodgepole pine, and ponderosa pine. About 14,900 acres were mapped.

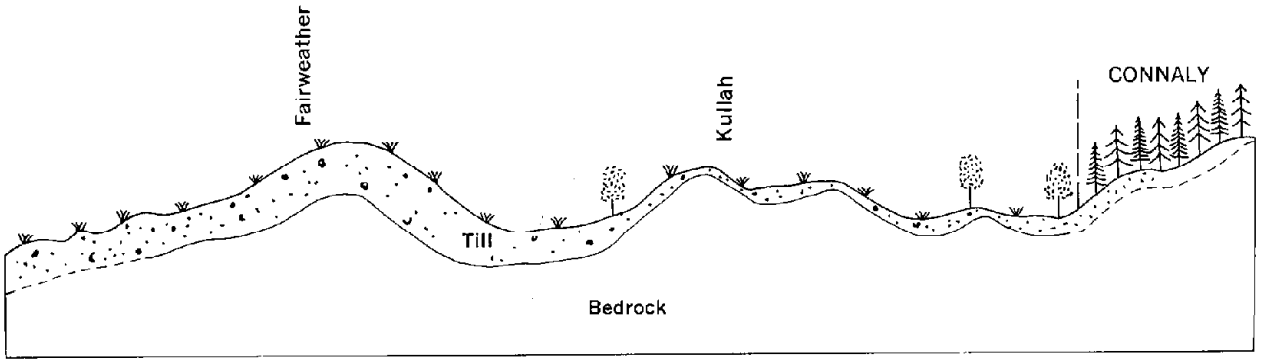
The Fairweather Map Unit

The Fairweather catena consists of Chernozemic soils developed on a drumlinized till plain. These soils occur at elevations of 3500 to 3900 feet east of the Quilchena Valley. They cover about 4600 acres. The main body of the catena lies north of the area.

The parent material is moderately fine to fine textured, moderately alkaline till. It is weakly saline, generally gravelly, and contains occasional large boulders. The native grassland vegetation consists of bunch grasses, forbs, and sedges. The topography is irregular and strongly to steeply sloping.

The Fairweather catena contains the Fairweather (Eluviated Black) and Kullah (Lithic Dark Brown) series.

FAIRWEATHER



Fairweather is the dominant series. It is a well-drained soil, occurring on mid-slopes of drumlins and ridges. Infiltration is slow and permeability is very slow in the subsoil. The soil has thick, very dark gray loam surface horizons (Ah, AB) over brown subsoil (Bt) and calcareous parent material (Ck). The Fairweather series resembles other Black Chernozemic soils on till, but it is developed on finer textured, more alkaline parent material.

Kullah soils are shallow and occur on steeply sloping irregular ridges, which are frequently stony and eroded. Kullah soils resemble those of the Miner series, but they are heavier textured and show stronger horizon development. The profile has dark brown surface horizons (Ah) and brownish subsoil horizons (Bm) that overlie bedrock (R) 4 to 20 inches from the surface.

Fairweather soils occur under a favorable climate that is limited by aridity. Stoniness is not a limitation. The irregular, steeply sloping terrain limits agricultural use to improved pasture. Kullah soils are droughty and stony, but they provide some native forage for livestock and wildlife.

One unit was established in the area.

Fairweather (FA)

This unit contains 70% to 80% Fairweather series and 20% to 30% Kullah series and Rock Outcrop. One section was mapped at the northern boundary of the area. It provides valuable spring and fall grazing for livestock, but has no value for forestry. About 4600 acres were mapped.

The Grant Map Unit

The Grant catena consists chiefly of Gray Luvisol soils. They occur in the upper Quilchena Valley at elevations of 4600 to 5500 feet. The soils are developed on a gently to moderately sloping fluted till plain. The catena covers about 4200 acres.

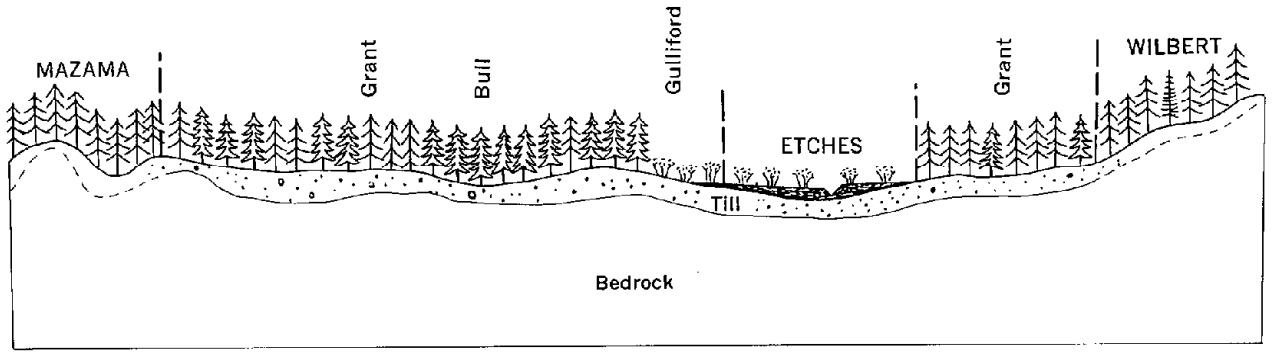
The main tree species is lodgepole pine, but regeneration is mainly to Engelmann spruce and subalpine fir. The characteristic ground cover includes red alpine blueberry, black mountain huckleberry, false-box, and arnica.

The parent materials are deep, moderately coarse and medium textured, slightly acid till. Lime carbonate generally occurs 5 to 6 feet from the surface.

The Grant catena contains the Grant (Brunisolic Gray Luvisol), Bull (Gleyed Orthic Gray Luvisol), and Gulliford (Rego Humic Gleysol) soil series.

Grant, the dominant soil series, occupies the upper slopes of low, gently sloping ridges. Infiltration rates are moderately high and permeability is moderate, decreasing to slow in the subsoil. These soils are moderately well drained. Surface textures are sandy loam and loam. The profile has up to 12 inches of brownish loam horizons (Bm) over grayish brown loam ("C" or Ae2) and moderately well developed subsoil horizons (Bt).

GRANT



The major association is with Mazama soils near Pennask Lake (Figure 6). Mazama soils are better drained and generally lighter textured than soils of the Grant series. Grant soils occur with Henning soils near Missezula Lake.

Bull soils occupy toe slope positions. They have developed under bunchberry, wintergreen, twinflower, and moisture-loving forbs and grasses. Bull soils are imperfectly drained and are characterized by litter horizons (L–F) over grayish sandy loam (Ae) that overlies mottled clay loam (Btg).

The *Gulliford* soils have thick litter horizons (L–F–H) and thick, dark-colored loam horizons (Ah) that overlie mottled loam (Cg). They occur in poorly drained depressions and seepageways and are often associated with peaty deposits (Etches series). See Figure 7.

Because of a short growing season and excessive wetness, the soils of this catena are limited to use for production of some forage crops and pasture.

Forest trees on soils of the Grant and Bull series have annual growth rates of 50 to 90 cubic feet per acre. The moderately well drained Grant series is best suited to the establishment and growth of lodgepole pine. The imperfectly drained Bull series is best suited to Engelmann spruce. Bull soils can yield over 90 cubic feet of wood per acre annually.

These soils provide forage and wintering habitat for mule deer and some moose.

One unit was mapped in the area.

Figure 6. Drumlinized ridges of the Mazama–Grant map unit near Pennask Lake, elevation about 5000 feet.

Figure 7. Vegetation on Gulliford loam, a Rego Humic Gleysol of the Grant catena. Growth of spruce and lodgepole pine is generally good on these sites.

Grant (GR)

This unit occupies gently sloping, imperfectly drained terrain near Pennask Lake. It is well suited to the production of lodgepole pine and Engelmann spruce. Temporary grazing for livestock may occur for short periods following logging or fires. It is valuable winter range for wildlife. About 4200 acres were mapped.

The Mazama Map Unit

The Mazama catena consists chiefly of Brunisolic soils developed over elevations that range from 4500 to 5500 feet on the Thompson Plateau. The characteristic landform has gently to strongly rolling ridge and swale topography. A brownish, moderately coarse textured, neutral to slightly acid sandy loam till is the parent material of the soils. The till is relatively deep and loosely consolidated on ridge slopes. On ridge crests, the parent materials are thinner, semiconsolidated, and generally overlie bedrock. The soils of the catena cover about 121,600 acres (Figure 8).

The vegetation on well-drained soils is mainly lodgepole pine in medium to dense stands, with regeneration favoring Engelmann spruce and subalpine fir. On the imperfectly drained lower slopes, which receive more moisture, the characteristic plants of the ground cover are bunchberry, wintergreen, and twinflower.

The Mazama catena consists of the Mazama (Degraded Eutric Brunisol), Bankeir (Lithic Orthic Eutric Brunisol) and Pefferle (Gleyed Degraded Eutric Brunisol) soil series.

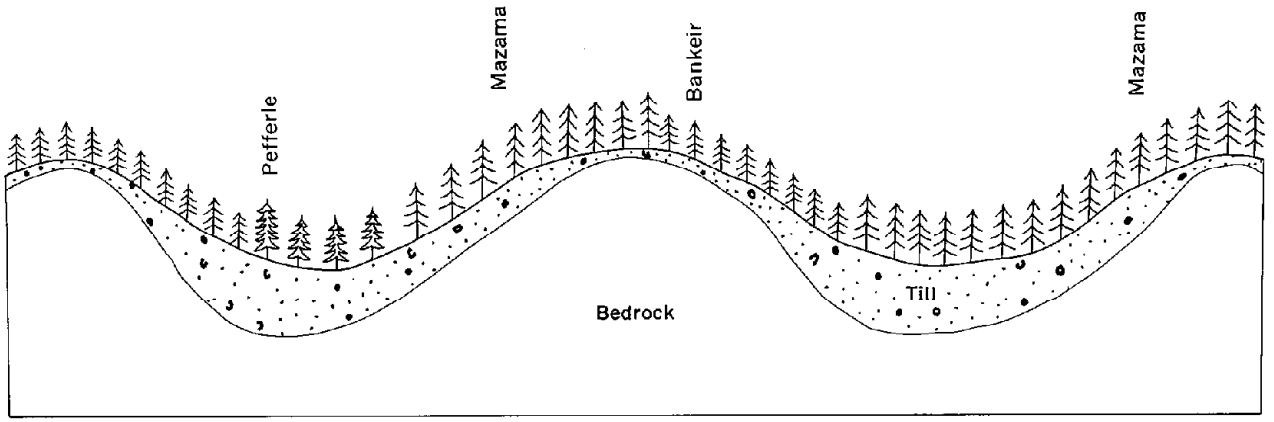


Figure 8. Meltwater channel cut into volcanic rocks underlying the Mazama catena. Within the channel, readily available soil moisture supports good growth of Douglas-fir and Engelmann spruce.

Mazama, the main soil series, occupies mid-slope positions on drumlinoid ridges. The profile has a thin, distinct, leached horizon (Ae) under the leaf litter, pale brown sandy loam horizons (Bm), and several grayish, weakly developed horizons (Btj) in the subsoil. Slightly alkaline, sandy loam horizons (CB) occur below a depth of 6 feet from the surface. These sandy loam and fine sandy loam soils are well drained, deep, and moderately permeable in all horizons.

The Mazama series is associated with the Grant and Bull soil series. An extensive acreage of Mazama and Grant soils occurs near Pennask Lake. Grant soils are heavier textured and less well drained than Mazama soils. One small unit of Mazama and Henning soils occurs near Mount Kathleen. Wilbert soils resemble Mazama soils but have developed on more acid materials.

Bankeir soils occupy the crests of small knolls and rock-cored drumlinoid ridges within the map unit. These lithic soils are well to rapidly drained and are associated with a semiopen type of forest containing Douglas-fir, lodgepole pine, pine grass, and shrubs. Bankeir soils are characterized by thin litter layers (L–F) and brown sandy loam or loam (Bm) that grades through a transitional horizon (BC) to weathered rock (R). Rock underlies the soil profile at 4 to 20 inches below the surface (Figure 9).

Pefferle soils occur on lower slopes below Mazama soils. Generally these soils occur on toe slopes on steeply sloping topography or occupy concave slope positions. Soil drainage is imperfect under a moist environment that supports a plant community of Engelmann spruce, subalpine fir, bunchberry, arnica, blueberries, and many moisture-loving forbs. The soil has a litter layer (L–F) of conifer needles and mosses, a thick, grayish, sandy loam leached horizon (Ae), and a mottled sandy loam (Bmg, Btjg) subsoil over neutral loamy sand parent material (C).

Although most of the Mazama and Pefferle soils have favorable topography, the short cool growing season severely restricts crop production. Following logging operations and fires, these soils may have grazing capacity for

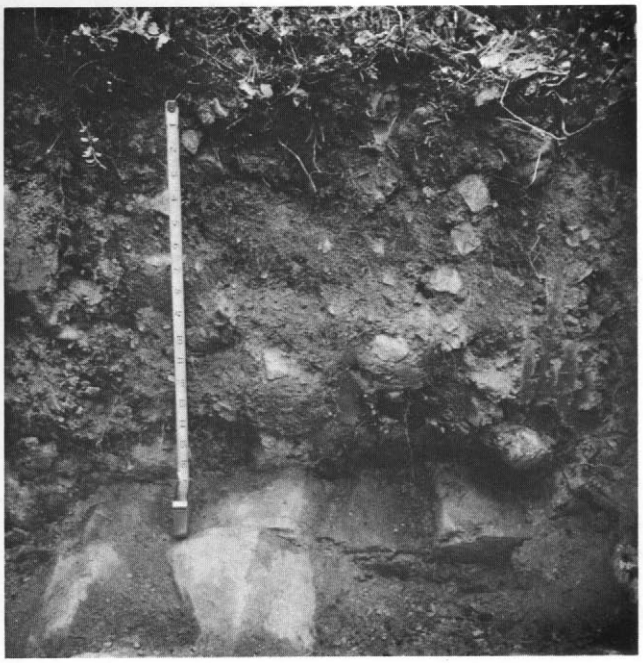


Figure 9. Bankeir sandy loam, a Lithic Eutric Brunisol, at elevation 4500 feet.

Figure 10. Grasslands on Chernozemic soils of the Princeton catena. The Tulameen – Rock Outcrop map unit is on the treed ridge; the Wilbert map unit occupies the plateau in the background.

several years. Because of their more open forest and grass cover, Bankeir soils have some value for grazing.

The gleyed Pefferle soils can produce high yields of merchantable timber, yielding 90 or more cubic feet per acre annually of Engelmann spruce and lodgepole pine. Lodgepole pine yields from 50 to 90 cubic feet per year on Mazama soils. Bankeir soils have a productivity of less than 50 cubic feet.

One map unit occurs in the area.

Mazama (MZ)

This unit contains about 50% Mazama, 30% Bankeir, and 20% Pefferle series. It occurs mainly on a drumlinoid landform of gently to moderately rolling topography. The unit is unsuitable for agriculture, but it has a moderately high value for forest production. Mule deer and some moose winter in sheltered parts of the unit. About 121,600 acres were mapped.

The Princeton Map Unit

The Princeton catena consists mainly of well-drained Chernozemic soils developed on weakly calcareous sandy loam and loam till. The till is derived mainly from weathered shales and volcanic rocks with granodiorite inclusions. The drumlinized till plain has a moderately to steeply sloping surface and an elevation of 2400 to 3600 feet. Princeton soils cover about 5100 acres, mainly in the upper grasslands north of the village of Princeton (Figure 10).

The native vegetation on the well-drained soils consists of Idaho fescue, bluebunch wheat grass, silvery lupine, tall white eriogonum, and fleabane. Poorly drained sites are characterized by meadow grasses, sedges, and scattered trembling aspen.

The Princeton catena contains the Princeton (Orthic Black), Separation [(Cumulic) Eluviated Black], Miner (Lithic Rego Dark Brown), and Collett (Carbonated Rego Dark Gray) soil series.

Princeton is the dominant series. Soils of this series are well-drained and occur on mid-slopes of ridges and drumlins. On these intermediate slope positions, they lie between the upper lithic soils and the cumulic and imperfectly drained soils of the lower slopes and depressions. Infiltration is rapid and permeability is moderate. Loam is the dominant surface texture, but sandy loam and fine sandy loam textures are common.

Princeton soils have very dark gray to black surface horizons (Ah) 8 to 10 inches thick, and thin transitional horizons (BA). The subsoil horizon (Bm) is brown and grades into a pale brown compact sandy loam horizon (Cl) at a depth of about 2 feet. The parent material contains occasional pockets of lime carbonate near bedrock at depths of 2 to 10 feet (Figure 11).

Princeton soils are associated with soils of the Brenda and Galena series.

Separation soils occupy steep lower slopes below the Princeton soils. These well-drained soils have thick, dark surface horizons (Ah) formed by downslope movement of the accumulated materials overlying former A and B

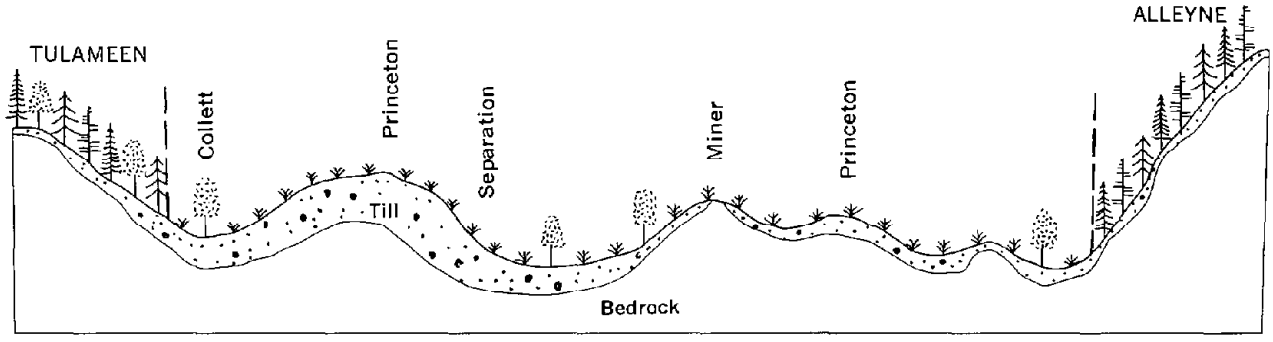


Figure 11. Princeton sandy loam, an Orthic Black. The till parent material is underlain by volcanic rocks of the Nicola Group.

horizons. The profile is friable and is generally less consolidated than that of the Princeton series.

Miner soils are rapidly drained and occur on steep, eroded ridge crests above other soils of the catena. The brownish surface horizons (Ah) grade into weathered rock (R) at depths of 4 to 20 inches below the surface.

The *Collett* soil series occupies imperfectly drained positions adjacent to Separation soils. The Collett soils are characterized by thick, dark surface horizons (Ah, Ahe) that overlie a slightly mottled subsoil. Free lime is often found near the surface.

Minor soil members of the catena include Orthic Dark Brown soils developed on arid eroded knolls, and Gleysolic soils associated with the Collett series in wet depressions.

Where topography is not a limitation, Princeton soils have been dry farmed for cereal grains. However, topographic limitations, droughtiness, and restriction of the rooting zone by stones and bedrock limit most of these soils to use for permanent pasture. Under the native bunch grass vegetation, Princeton and Separation soils produce forage yields of more than 1000 pounds per acre. Mule deer make extensive use of these soils in early spring and late fall. Collett soils provide limited summer grazing. Steep topography, low moisture-holding capacity, and stoniness restrict Miner soils to use as unimproved pasture. Soils of the catena have no value for forest production.

One map unit was established in the Tulameen area.

Princeton (PR)

This unit contains more than 60% Princeton soils and varying amounts of Separation, Collett, and Miner soils. The unit has a very high productivity for pasture and forage crops, but is seriously overgrazed at present. Land suitable for annual crops is limited by size and by lack of irrigation water. About 5100 acres were mapped.

UNDIVIDED TILL AND COLLUVIAL DEPOSITS

The materials from which the soils of the Alleyne, Bonnevier, Lawless, Tulameen, and Wilbert map units have developed are acid loamy sands and sandy loams. They are mainly till deposits and are generally covered by 1 to 5 feet of colluvium. The mapping of these materials was done largely by air photo interpretation.

The Alleyne Map Unit

The Alleyne catena consists mainly of Brunisolic soils. Relief is high to moderate and elevations range from

3000 to 4500 feet. Soils of this catena cover about 41,500 acres in the central and eastern parts of the area.

Parent materials are moderately coarse and medium textured, slightly acid to neutral colluvial and till deposits. They occur mainly on steep and very steep slopes of valleys and meltwater channels.

The vegetation consists of Douglas-fir associated with ponderosa pine and lodgepole pine in moderately dense stands. Pine grass dominates the understory and there is a sparse cover of bearberry, saskatoon, and forbs. On dry, southerly aspects Idaho fescue occurs under an open forest canopy.

The Alleyne catena contains the Alleyne (Degraded Eutric Brunisol) and Darcy (Orthic Dark Gray) soil series.

Alleyne is the dominant soil series. These soils are well drained, permeable through the A and B horizons, and moderately permeable in the parent material. The profile has very thick, light gray leached horizons (Ae), and pale brown sandy loam (Bm) over one or more horizons (Btj, BC) in which some clay has accumulated.

Alleyne soils are associated with soils of the Tulameen, Asp, Thalia, and Connaly series and with the Steeplands and Rock Outcrop land types.

Darcy soils are well drained and occur on steep, convex, south- and west-facing slopes. These soils have developed under open forest and grassland areas within the catena. Darcy soils have thin organic horizons (F–H) that overlie 6 inches of dark gray sandy loam (Ahe) and brown lower horizons (Bm). The parent material is generally underlain by compact till or rock.

Topographic limitations on soils of the Alleyne catena prohibit arable agriculture. The soils, particularly Darcy sandy loam, provide important winter range for mule deer and have limited use for domestic grazing.

Soils of the Alleyne catena are severely limited by moisture deficiency and restricted rooting. They produce less than 50 cubic feet of wood per acre annually of Douglas-fir and ponderosa pine.

The soils generally provide suitable materials for road construction, but rock outcrops and seepage increase construction costs and road maintenance.

One unit was recognized in the surveyed area.

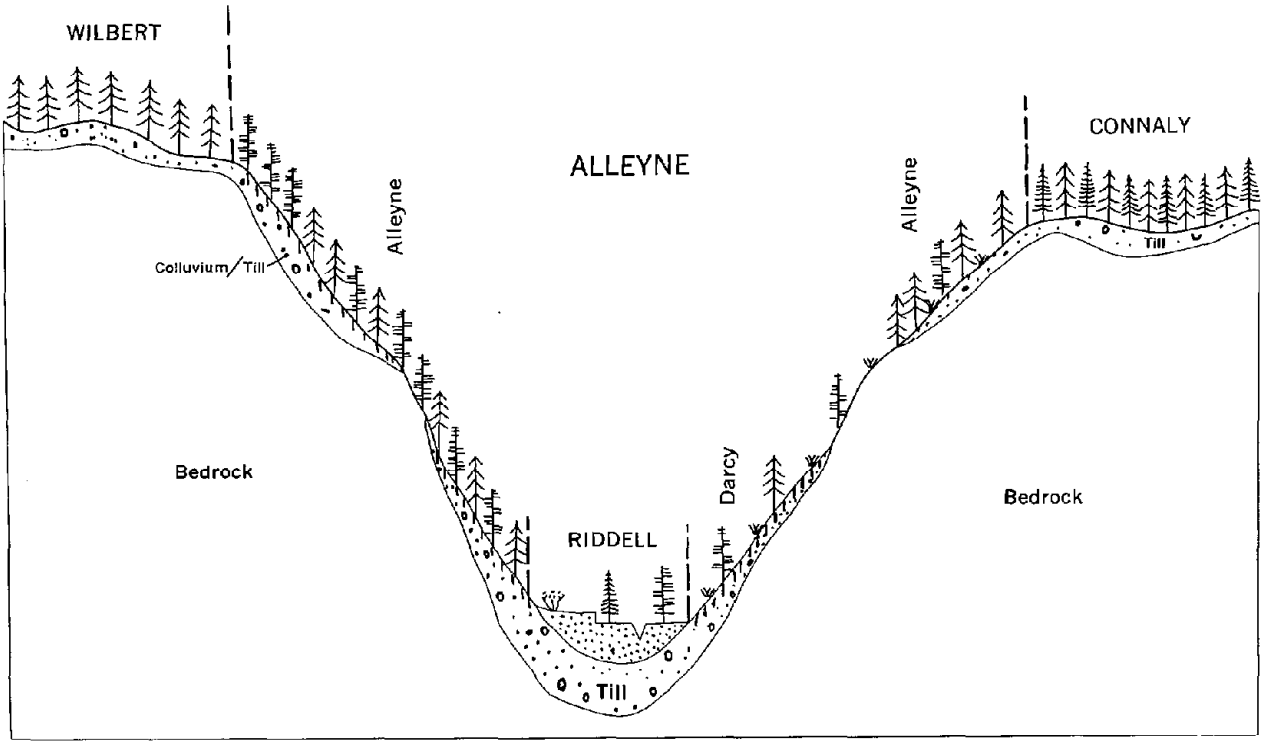
Alleyne (AY)

This unit generally contains 70% to 80% Alleyne soils, but the percentage of Darcy series increases to about 40% on some south-facing aspects. These soils mainly support winter range for mule deer. About 41,500 acres were mapped.

The Bonnevier Map Unit

The Bonnevier catena consists of Brunisolic and Podzolic soils on the highest elevations of the Okanagan Range and Cascade Mountains. The soil units are confined to mountain ridges near the tree line at 5800 to 6600 feet. Parent materials of the soils are coarse textured, strongly acid materials that include till, colluvium, and aeolian deposits. The soils cover about 1800 acres in the Tulameen area.

The soils of the catena occur on smooth, moderately to strongly sloping topography in a subalpine plant community. The soils have developed under an open parkland



covered by red alpine blueberry, false-box, false-heathers, arnica, mountain valerian, alpine grasses, sedges, and forbs. At the tree line, Engelmann spruce, subalpine fir, lodgepole pine, and whitebark pine have tapered, stunted forms and occur singly or in clumps.

The Bonnevier catena consists of the Bonnevier (Alpine Dystric Brunisol), Chuwanten (Gleyed Alpine Dystric Brunisol), and Pitin (Sombric Humo-Ferric Podzol) soil series.

Bonnevier is the dominant soil series. It is a well-drained, moderately permeable soil that occurs on upper ridge slopes under grass and forb cover. The profile has thin surface layers (L–H) of litter and thick, dark surface horizons (Ah). These brown, turfy horizons have a dense mat of fine roots and organic matter intermixed with fine sand. One or more yellowish brown horizons (Bm) underlie the Ah horizons. The subsoil horizons (BC) are compact and stony (Figure 12).

Bonnevier soils occur with the Nicomen series and Rock Outcrop.

Chuwanten soils are moderately well to imperfectly drained. They occupy swales and toe slopes, which support a lush growth of forbs, sedges, and grasses. The profile has a horizon sequence similar to that of the Bonnevier series, but the colors are duller, and gleying occurs in the subsoil.

Pitin soils are well drained and moderately permeable. They occur under forb and shrub cover on upper ridge positions. The soils have thick, turfy horizons (Ah) over yellowish brown fine sandy loam (Bf) and gravelly sandy loam horizons (C).

A short, cool growing season restricts agricultural use of the soils of the Bonnevier catena to summer and early fall grazing.

The growth of commercial forest trees is severely limited by deep snow accumulation, the short, cool growing season, and bedrock in the rooting zone. The annual growth of trees is generally less than 10 cubic feet per acre on Bonnevier and Chuwanten soils. Pitin soils may produce good yields of spruce.

The soils of the Bonnevier catena support summer browse and shelter for ungulates.

The Bonnevier catena has a high potential for recreational use.

One map unit was established in the Tulameen area.

Bonnevier (BV)

This unit contains about 60% Bonnevier, 20% Chuwanten, and 20% Pitin soils. Nicomen soils are closely associated with the Bonnevier and Pitin series and make up varying percentages of the map unit. These soil units, which are fairly small, are found on the highest points in the area—Mount Thynne (6649 feet), Mount Kathleen (6308 feet), and Pennask Mountain (6545 feet). These

BONNEVIER

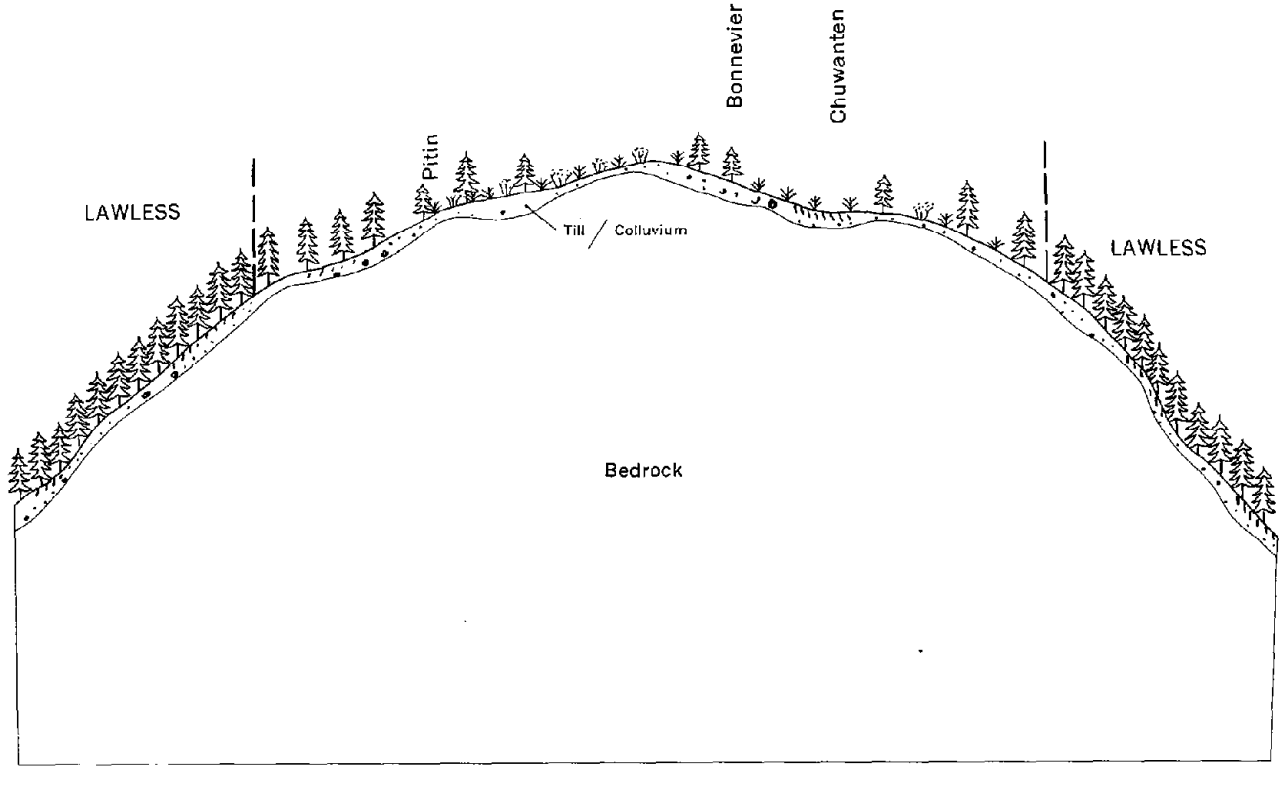


Figure 12. Bonnevier sandy loam, an Alpine Dystric Brunisol near the tree line at 6600 feet.

soil units are little used by livestock and have limited forest capability. Their chief use is for wildlife and recreation. About 1800 acres were mapped.

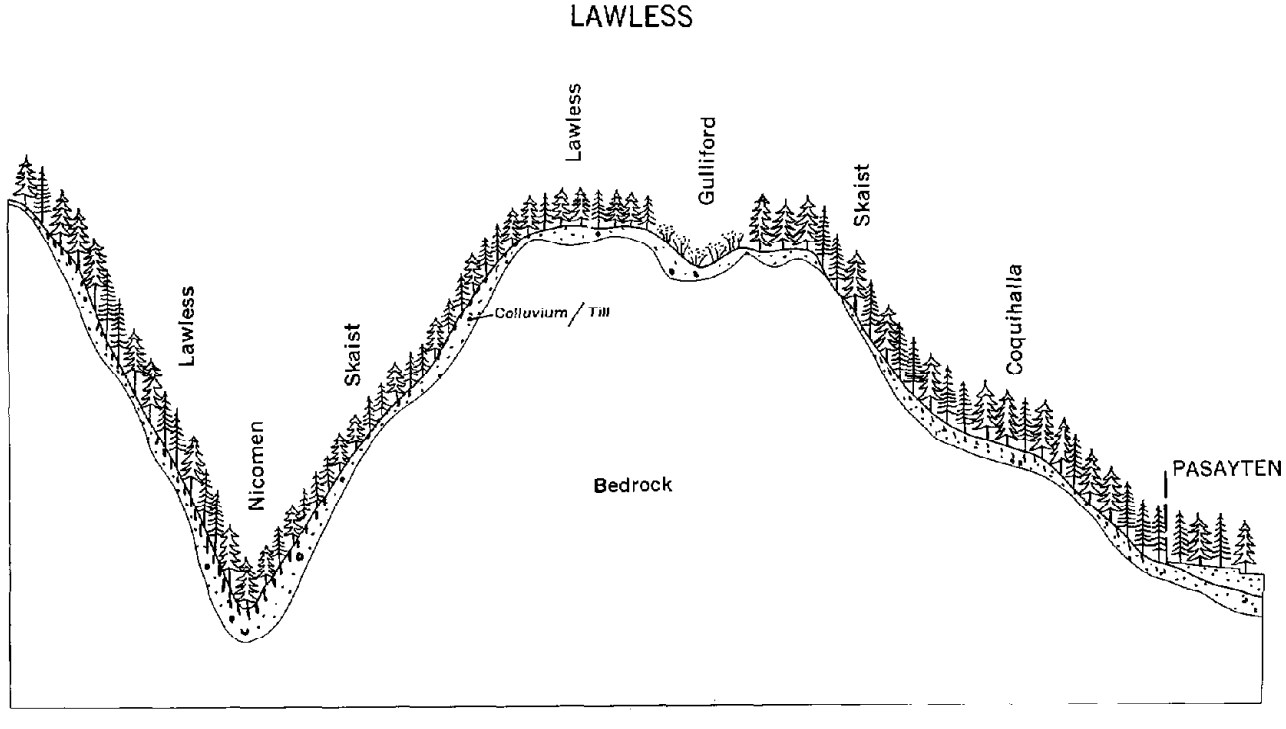
The Lawless Map Unit

The Lawless catena consists mainly of Podzolic soils developed on undifferentiated colluvial and till deposits. These soils cover about 139,200 acres in mountainous parts of the area where elevations range from 4000 to 6000 feet.

The parent materials are coarse textured, slightly to moderately acid colluvium and till derived from weathered lavas, argillites, and granodiorites. The landform consists mainly of steep to extremely steep mountain slopes and ridges of high and moderate relief. The dense coniferous forest contains many species of trees, shrubs, and forbs. Common trees are subalpine fir, Engelmann spruce, Douglas-fir, mountain hemlock, western red cedar, and western white pine. Plants of the understory include blueberries, false-box, bunch berry, and a variety of forbs.

The Lawless catena contains the Lawless (Mini Humo-Ferric Podzol), Nicomen (Orthic Humo-Ferric Podzol), Skaist (Lithic Mini Humo-Ferric Podzol), and Coquihalla (Mini Ferro-Humic Podzol) soil series.

Lawless, the dominant soil, is well drained and occurs on steep side slopes of mountain valleys and plateau ridges. Infiltration is rapid, and permeability is moderate in surface horizons and slow in the lower B and C horizons. The soil profile is developed on semiconsolidated, coarse textured colluvium or till that commonly overlies compact basal till at depths of 2 to 4 feet. The Lawless soil has thick litter horizons (L–F–H) and a grayish horizon



(Ae) that is thin and discontinuous. The subsoil horizons (Bfh, Bf) are yellowish brown or yellowish red.

Lawless soils are associated with soils of the Bonnevier series and Rock Outcrop on high mountain ridges.

Nicomen soils are well drained and moderately permeable. They occur in slightly concave positions on toe slopes. The profile has a horizon sequence similar to that of the Lawless series, but the leached horizon (Ae) is 1 or more inches thick and colors are more strongly expressed in the subsoil horizons (Bfh, Bf).

Skaist soils usually occupy abraded ridge crests and convex slope positions. The soils are well drained, runoff is rapid, and permeability is slow near the bedrock boundary. The profile has yellowish brown horizons (Bfh, Bf) and a transitional lower horizon (BC) that overlies rock (R) at depths of 4 to 20 inches.

Coquihalla soils are well drained and occur on very steep west-facing slopes of the Coldwater River valley. They have thick litter horizons (L, F–H) that overlie dark yellowish brown sandy loam (Bf, Bfh) over sandy loam parent material (Cl).

Soils of the Lawless catena occur in mountainous terrain where adverse climate and topography severely limit agricultural use. Livestock may be grazed during the summer on logged or burned-over land or in semiopen sections that contain a high percentage of Gleysolic and Organic soils (Gulliford and Etches series).

The deep, well-drained Lawless, Nicomen, and Coquihalla soils, which receive a constant supply of telluric waters throughout the growing season, have no limitations for spruce. Productivity on these soils is 90 to 110 cubic feet per acre per year or more. The lithic Skaist series is severely limited by restrictions to root growth and by droughtiness. The Gulliford series generally has an annual productivity of over 70 cubic feet per acre.

Mule deer use the Skaist and Lawless soils near timberline as summer range. Blue and willow grouse occur throughout the area.

Three map units were differentiated in the area.

Lawless 1 (LW 1)

This unit contains about 60% Lawless and 20% each of Nicomen and Skaist soils. These map units are situated on steep to very steep mountain slopes in the watershed of the Tulameen River and on the high plateau northeast of Princeton village. Soils in the unit are unsuited to agriculture, but they have a high capability for timber production (Figure 13). Other uses include wildlife habitat and watershed protection. About 118,500 acres were mapped.

Lawless 2 (LW 2)

One large unit south of Trout Creek was mapped in the area. It contains 80% Lawless and Nicomen soils and about 20% Gulliford series. Many small units of Organic soils, mainly of the Etches series, occur on the plateau. This map unit has limited use as summer range for livestock and wildlife. Some selective logging of Engelmann spruce may take place. About 13,300 acres were mapped.

Figure 13. Engelmann spruce, 250 years old, being logged on Lawless, a Mini Humo-Ferric Podzol, and Skaist, a Lithic Humo-Ferric Podzol. The mean annual increment of spruce may exceed 110 cubic feet per acre on these sites.

Lawless 3 (LW 3)

This unit occupies very steep, mainly west-facing mountain slopes above the Coldwater River valley. It contains 80% Lawless and Nicomen series and 20% Coquihalla series. The dense forest on the soils covered by this map unit contains several species of trees, shrubs, and forbs that are common to the wet coastal hemlock zone. The primary land use is timber production. About 7400 acres were mapped.

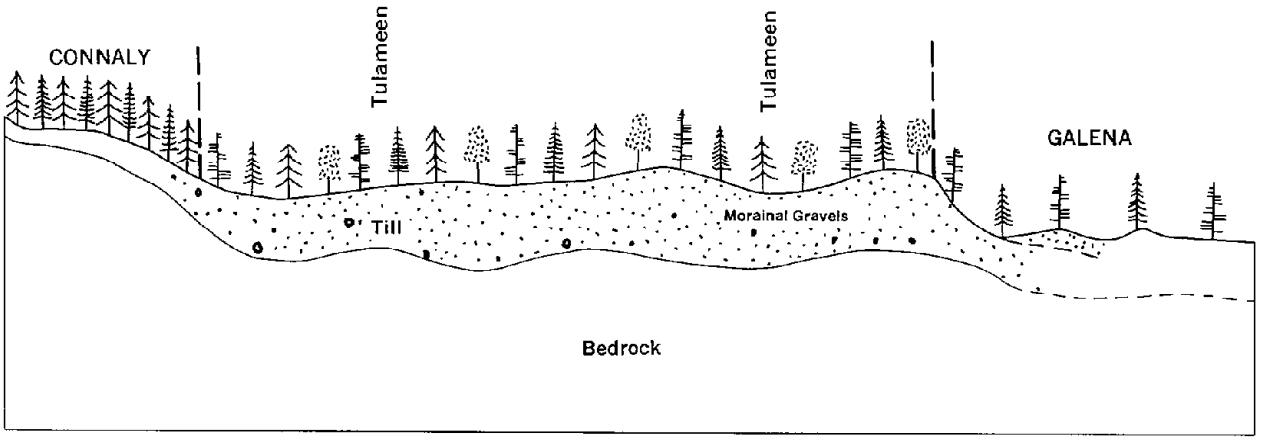
The Tulameen Map Unit

The Tulameen catena consists mainly of Luvisolic soils that have developed on coarse textured till and morainal gravels in the dry forest parts of the Princeton basin. Elevations range from 2600 to 3400 feet. The soils cover about 3900 acres.

Parent materials are semiconsolidated, mildly alkaline, gravelly sandy loams. The gently to moderately sloping land surface is interrupted by low knolls and steep-sided gullies. The semiopen cover of Douglas-fir, trembling aspen, ponderosa pine, and lodgepole pine has a sparse understory of shrubs, pine grass, and forbs.

The Tulameen catena is dominated by Orthic Gray Luvisol soils of the Tulameen series.

TULAMEEN



Tulameen soils are well drained and rapidly permeable. They have thick, leached horizons (Ae) that are underlain by horizons of clay accumulation (Btj, Bt). Lime carbonate is generally present at depths of 6 feet or more.

Tulameen soils are associated with the Princeton, Connaly, and Alleyne series.

Soils of the Tulameen catena have moderate climatic limitations. Low moisture-holding capacity and stoniness restrict the agricultural capability to improved pasture, grazing, and some forage crop production.

On these soils ponderosa pine and Douglas-fir have an annual growth rate of 30 to 70 cubic feet per acre. The main limitation to tree growth is low moisture-holding capacity.

The soils provide some early spring browse for wildlife.

One unit was established in the area.

Tulameen (TU)

This unit contains 50% to 70% Tulameen series and 30% to 40% Alleyne series. Its main use is grazing by domestic stock and wildlife. About 3900 acres were mapped.

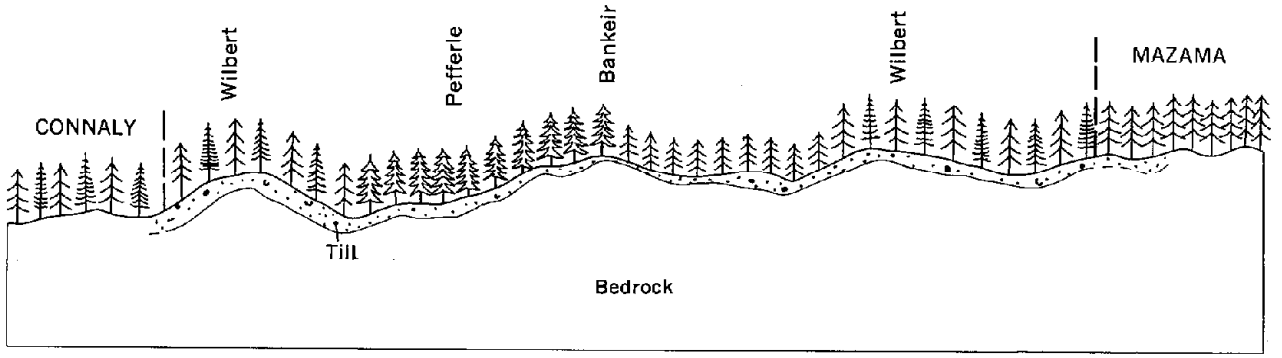
The Wilbert Map Unit

The Wilbert catena consists chiefly of Brunisolic soils, which occupy much of the plateau above 4000 feet. The soils have developed on morainal deposits of moderately coarse textured, slightly acid till and colluvium. They cover about 307,400 acres, almost one-third of the total area.

The terrain consists of moderately to steeply sloping plateau ridges with low to moderate relief. Abraded ridges, on which Rock Outcrop and shallow soils are common, are interspersed with rolling uplands. Lodgepole pine, the dominant tree in the uplands section, occurs with Douglas-fir; subalpine fir and Engelmann spruce favor moist sites. The ground cover includes red alpine blueberry, pine grass, twinflower, false-box, arnica, and wintergreen.

Wilbert soils are Degraded Dystric Brunisols that have developed on well-drained, moderate to steep-sided ridge slopes. The soil has organic surface layers (L–F–H) over a thin grayish leached horizon (Ae). Brown subsoil horizons (Bm) overlie gravelly, strongly acid sandy loam (C).

WILBERT



Wilbert soils are similar to Mazama soils, but they have developed on more acidic till and colluvium. Drumlinized landforms are more common to Mazama soils. Soils of the Wilbert catena occur with Bankeir and Pefferle soils. Bankeir soils occupy abraded ridge crests and upper slopes. Pefferle soils occur on slopes below the Wilbert soils.

The Gulliford (Rego Humic Gleysol) and Etches (Terric Mesisol) series occupy drainages and depressions. These poorly drained soils form less than 20% inclusions within the catena.

Soils of the Wilbert catena occur at elevations above 4000 feet, where the short growing season and frost-free period limit crop production. Steep topography and the low moisture-holding capacity of Wilbert soils are further limitations to agriculture. The carrying capacity on Wilbert soils may increase temporarily after logging or fires.

Lodgepole pine on well-drained Wilbert soils has an annual productivity of 90 or more cubic feet per acre.

In the Tulameen area one map unit was established.

Wilbert (W1)

This map unit is a complex of soils belonging to the Wilbert and Mazama catenas. The Wilbert series occupies about 60% of the unit and has developed on strongly acidic parent materials. Pefferle and Bankeir soils of the Mazama catena, which have developed on slightly acid to neutral till, make up most of the rest of the unit. The map unit occupies moderately sloping plateau ridges and slopes of low to moderate relief. The soils have low capability for crop production and grazing. Timber harvesting and wildlife are the main uses. About 307,400 acres were mapped.

Isolated ridges in the unit are often dominated by Bankeir soils associated with Rock Outcrop. The areas of bare rock may comprise up to 40% of such complexes. Deer use the semiopen forest for browse.

SOILS ON LACUSTRINE DEPOSITS

Soils developed on lacustrine deposits occupy slightly less than 1% of the area. They are Gray Luvisols and Chernozemic soils and they comprise the Eastmere, Howarth, and Midday soil catenas. These soils occur in northern valleys, where the soil materials were deposited at the southern extensions of glacial lakes.

The Eastmere Map Unit

The Eastmere catena consists mainly of Gray Luvisol soils developed on ponded lake deposits. The soils cover about 570 acres at 4500 to 5000 feet above sea level near Paradise Lake.

The parent materials are acidic silts and fine sands that were deposited in temporary ponding basins during the retreat of local ice caps. Topography is gently to strongly sloping. The native vegetation includes subalpine fir, Engelmann spruce, and lodgepole pine, and a ground cover of bunchberry, false-box, blueberries, and mosses.

The Eastmere catena consists of the Eastmere (Brunisolic Gray Luvisol) and Boot (Cumulic Regosol) series.

Eastmere, the dominant series, consists of moderately well drained soils that occupy the upper and mid-slopes of ridges. They have loam and silt loam surface horizons (Ae, Bm) over pale brown silt loam (Bt, BC) that overlies stratified acidic parent material (C1, C2).

Soils of the *Boot* series are well drained and occupy the lower slopes that receive continual surface accumulations of soil material. These soils have thick silt loam surface horizons (Ah, Ahb) over brownish silty parent material (C1).

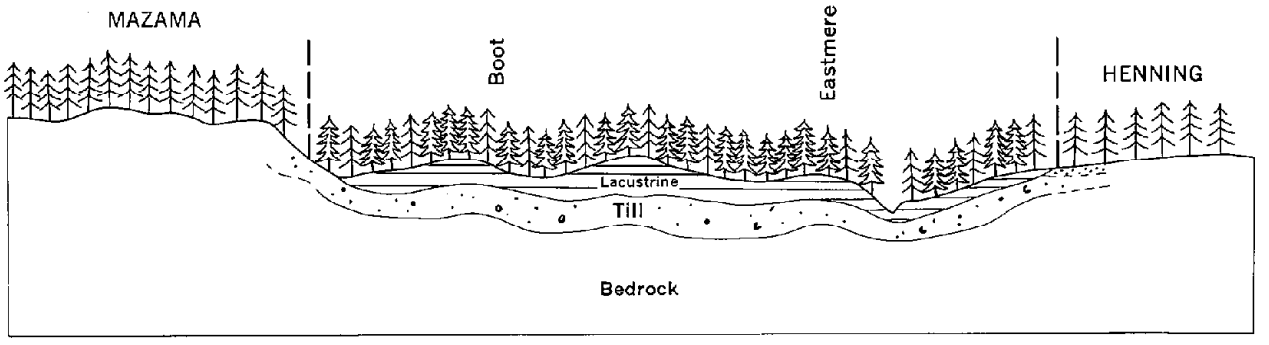
Eastmere and Boot soils have severe climatic restrictions that limit their capability to permanent pasture and hardy forage crops. The soils have a temporary capability for grazing after logging and fires.

The cumulative effects of minor soil factors are the only limitations to forest growth. The well-drained Eastmere series is best suited to the growth of lodgepole pine, whereas the Boot series is more suited to Engelmann spruce. The annual capabilities for both tree species range from 70 to 110 cubic feet of wood per acre on each soil.

The soils provide some wintering sites for mule deer.

One map unit was delineated.

EASTMERE



Eastmere (EA)

This map unit contains 70% to 80% Eastmere series and 20% to 30% Boot series. It has low capability for agriculture, but it is well suited to forest growth. About 570 acres were mapped.

The Howarth Map Unit

The Howarth catena consists of Chernozemic soils developed on lacustrine materials. These soils occur in the Quilchena and Otter Creek valleys at elevations of 3000 to 3500 feet. The general topography is irregular and moderately sloping. The soils cover about 7100 acres.

The parent materials are moderately alkaline lacustrine silts and fine sands. Much of this sediment was deposited over ice which, when it melted, left a "collapsed" landform of low, hummocky relief. The native vegetation is an open forest of Douglas-fir and ponderosa pine that includes many plants of the grasslands.

The Howarth catena consists of the Howarth (Orthic Dark Gray) and Corbett (Rego Dark Gray) soil series.

Howarth, the dominant soil series, is well drained and moderately permeable. The soils of this series have thin litter horizons (L–F), 8 to 10 inches of dark gray loam surface (Ahe), and silty clay subsoil horizons (Bm, Btj). Free lime occurs at depths of 30 to 45 inches.

Howarth soils are associated with Brenda soils and with Rock Outcrop adjacent to Quilchena Creek.

Soils of the *Corbett* series are well drained and are associated mainly with eroded landforms that are thinly mantled with silts and fine sands over bedrock. The soils have thick, dark gray silt loam surface horizons (Ahe), but lack the B horizon development of Howarth soils.

Soils of the Howarth catena occur on gently rolling topography in the Quilchena basin and have no agricultural limitations other than climate. The frost-free period is about 60 to 90 days and there are 1650 to 2150 degree-days. The soils are suitable for dry farming of cereal grains and sustained production of forage crops. Other units of Howarth soils have limitations of topography, rockiness, and droughtiness that restrict agricultural use to permanent pasture and to spring and fall grazing by stock and deer.

Tree growth on Howarth soils is severely restricted by moisture deficiency during the growing season. Wood production is limited to 10 to 30 cubic feet per acre annually. Ponderosa pine is suitable to a limited extent.

One unit was mapped in the area.

Howarth (HO)

This unit contains 70% to 80% Howarth and 20% to 30% Corbett soils. On gently rolling topography in the Quilchena Creek region the soils are now used mainly for livestock grazing. Steep, eroded land adjoining Quilchena Creek is 20% to 30% Rock Outcrop and is restricted to unimproved grazing by livestock and wildlife. About 7100 acres were mapped.

The Midday Map Unit

The Midday catena consists mainly of Gray Luvisol soils. This map unit occupies a lacustrine basin and terrace remnants drained by Midday Creek, a tributary of the Coldwater River. Elevations range from 2400 to 2700 feet on gently sloping land. The soils cover about 1700 acres.

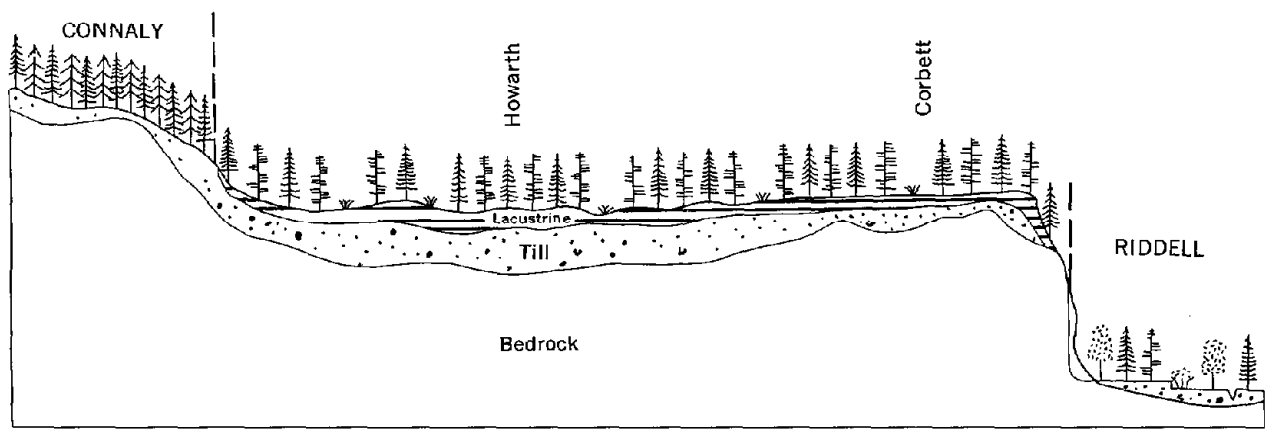
The parent materials are varved, mildly alkaline silty clays that were deposited by a former glacial lake. Vegetation is characterized by a semiopen canopy of Douglas-fir, ponderosa pine, and trembling aspen and a ground cover that includes pine grass, kinnikinnick, and buffaloberry.

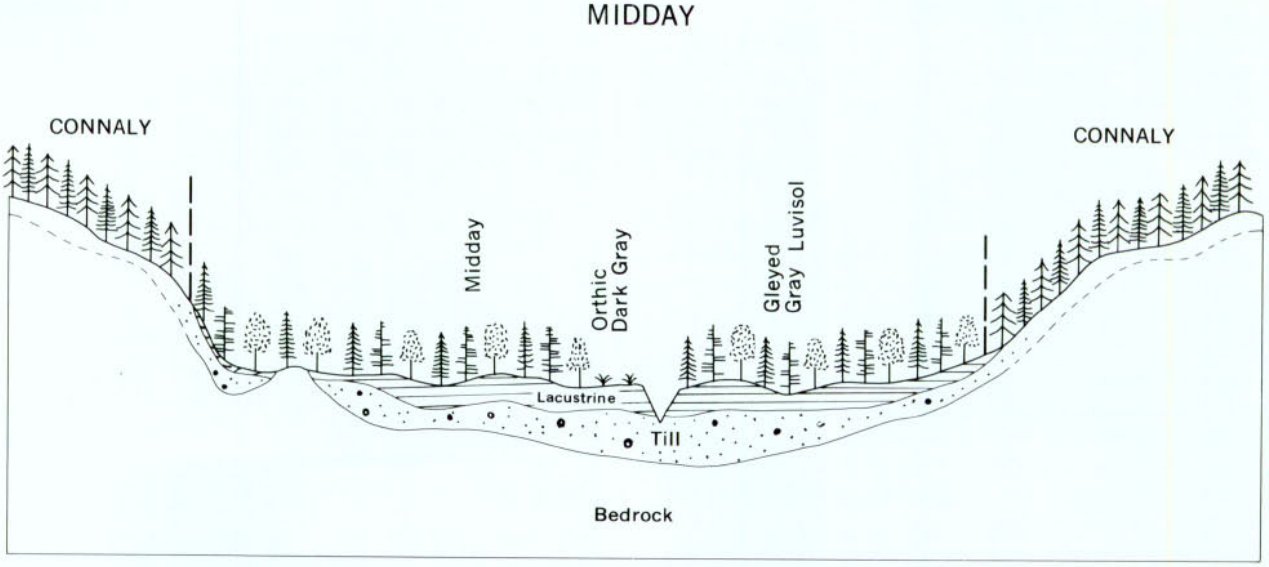
The Midday catena consists mainly of soils of the Orthic Gray Luvisol Midday series.

Midday soils have thin litter horizons (L–F), 4 to 8 inches of gray leached horizon (Ae) over columnar clay loam (Bt), and lime carbonate (Ck) at 14 inches.

The soils have only moderate climatic limitations that restrict the choice of crops. Cereal grains, hay, and forage crops can be grown under irrigation. Most of the Midday soils are topographically suitable for cropping and have no other limitations.

HOWARTH





Forest capability of the well-drained soils is limited to 30 to 70 cubic feet per acre annually of Douglas-fir and lodgepole pine.

One map unit was established.

Midday (MD)

This unit contains 70% to 80% Midday series and 20% to 30% gleyed Luvisolic and Chernozemic soils. Along the southwestern boundary of the unit, rock ridges protrude through the shallow lacustrine soil mantle. Almost the entire map unit of 1700 acres lies within the Paul's Basin Indian Reserve and is presently being developed for agriculture.

SOILS ON FLUVIAL AND GLACIOFLUVIAL DEPOSITS

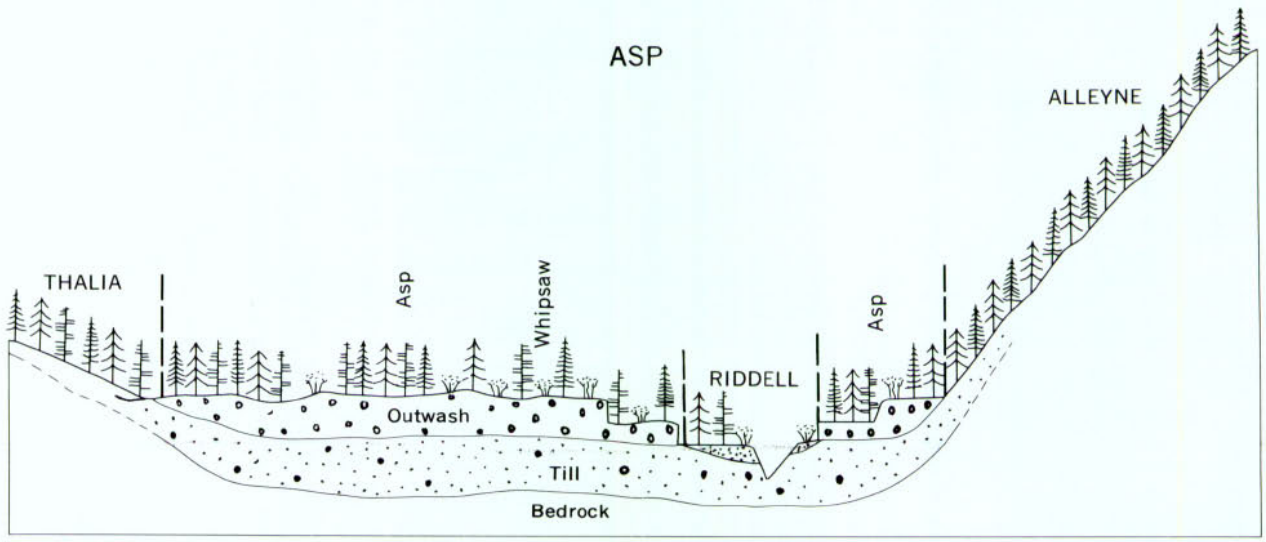
Soils developed on coarse outwash materials occupy almost 3% of the Tulameen area. Brunisolic soils dominate these map units on the valley terraces. Soils belong to the Asp, Galena, Henning, Pasayten, and Trehearne map units.

The Asp Map Unit

The Asp catena consists of Brunisolic soils developed on coarse textured outwash materials of the main valleys. The soils cover about 6200 acres at elevations of 2700 to 3500 feet.

The parent materials of the soils are sandy loam and gravelly loamy sand. These neutral to slightly alkaline materials overlie cobbly gravels at depths of 12 to 18 inches. The landforms are nearly level to moderately sloping terraces with some irregular steeply sloping kames and kettles.

The vegetative cover is a moderately dense forest of ponderosa pine, Douglas-fir, and lodgepole pine over an



understory of kinnikinnick, spirea, pine grass, bunch grasses, and forbs.

The Asp catena contains the Asp (Degraded Eutric Brunisol) and Whipsaw (Orthic Eutric Brunisol) soils.

Asp soils are rapidly drained and have high infiltration rates and rapid permeability. The profile is developed in 12 to 18 inches of loamy sand overlying cobbly gravel. Under 1 inch of leaf and grass litter (L–F), thin dark gray and gray horizons (Ahe, Aej) overlie brown loamy sand (Bm). Surface textures are loamy sand, gravelly loamy sand, and sandy loam (Figure 14).

Asp soils are associated with other coarse textured soils, including Galena, Henning, and Thalia series.

Whipsaw soils are rapidly drained and highly permeable. The soil profile has a dark surface (Ah), but does not have the leached horizon of Asp soils. The native plant cover generally includes more grassland plant species.

The soils of this catena are stony and have a low moisture-holding capacity. Topography is not usually a limitation for crops. Under irrigation, Asp and Whipsaw soils can produce a range of crops suited to the climate.

Asp and Whipsaw soils may have a forest capability of up to 50 cubic feet per acre annually for Douglas-fir and ponderosa pine, but most of these soils have moisture limitations that severely restrict commercial forestry.

One map unit was established.

Asp (AS)

This map unit contains 70% to 80% Asp and 20% to 30% Whipsaw series. It is used mainly as unimproved pasture for livestock. Some undeveloped units near accessible lakes and streams have good potential for campsites. About 6200 acres were mapped.

The Galena Map Unit

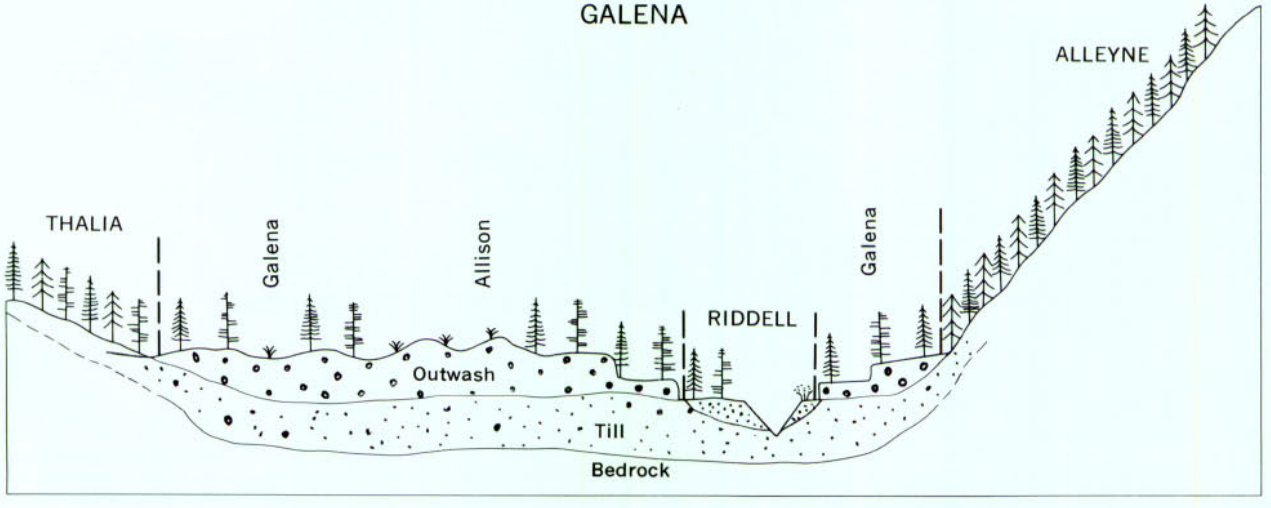
The Chernozemic soils of the Galena catena occur on outwash materials north of the village of Princeton and in the upper Otter and Kane valleys. Elevations range from 2300 to 3500 feet. The soils cover about 2800 acres.

Figure 14. Asp gravelly loamy sand, a Degraded Eutric Brunisol, on a coarse textured outwash terrace.

The parent materials are very coarse textured, slightly alkaline, gravelly loamy sands on outwash terraces. The topography is mainly gently sloping, but on kettled terraces it is irregular and hummocky.

The soils have developed under open stands of ponderosa pine and Douglas-fir that contain many grassy areas. These grasslands have a ground cover of bunch grasses and forbs.

The Galena catena contains the Galena (Orthic Dark Gray) and Allison (Orthic Black) soil series.



Galena is the dominant series. It is rapidly drained and highly permeable. The profile is generally less than 12 inches thick and overlies cobbly gravels. The surface horizons (Ahe) are dark grayish brown and grade into gravelly loamy sand (Bm).

Galena soils are associated with Asp, Thalia, and Princeton soils.

Allison soils are rapidly drained and highly permeable. They have developed under grassland vegetation. The profile has 4 to 6 inches of black loamy sand surface horizon (Ah) and a brown lower horizon (Bm). The topography is irregular and hummocky.

Although Galena and Allison soils have only moderate climatic restrictions for agricultural crops, they are severely limited by stoniness, droughtiness, and adverse topography.

These soils either have no capability for forestry or they are limited by low moisture-holding capacity and stoniness to annual growth rates of 10 to 30 cubic feet of wood per acre.

One map unit was established in the Tulameen area.

Galena (GA)

This unit contains 60% to 80% Galena and 20% to 40% Allison series. It produces high yields of native forage for early grazing by livestock and deer, but it has low capability for forestry. About 2800 acres were mapped.

The Henning Map Unit

The Henning catena consists mainly of Brunisolic soils developed on outwash terraces, kames, and eskers. The soils occur as scattered units at elevations of 2900 to 5000 feet. The catena covers about 15,700 acres.

The parent materials are strongly acid sandy loams overlying a cobbly gravel substratum. Most of the soils occur on nearly level terraces, but a kame–esker phase has steeply sloping hummocky topography.

The typical vegetation on Henning soils is characterized by lodgepole pine, pine grass, red alpine blueberry, and twinflower. At lower elevations, kinnikinnick, arnica, and occasional ponderosa pine form part of the plant community.

The Henning catena contains the Henning (Orthic Dystric Brunisol) and Parawest (Cumulic Regosol) soil series.

Henning, the main series, consists of rapidly drained and permeable soils. These soils have a thin litter horizon (L–F) that overlies brown sandy loam (Bm) 8 to 10 inches thick over a gravelly subsoil (IIBC, IIC). Some Henning soils near Pennask Lake have a deep surface mantle of sandy loam. (See Figure 15.) Degraded Dystric Brunisols occur with Henning soils on hummocky topography.

Henning soils are associated with soils of the Asp, Wilbert, Riddell, Mazama, Thalia, and Etches series.

Parawest soils occur mainly on hummocky topography associated with kames and eskers. They occupy moderately well drained positions near the base of slopes. The profile has a thick cumulic surface horizon (Ah, Ahb) overlying a discontinuous leached horizon (Ae) over parent material (C).

Low moisture-holding capacity, stoniness, and, in some places, topography limit the agricultural capabilities of Henning and Parawest soils. They can support forage crops, pasture, and hay.

The growth of trees on Henning soils is limited by soil moisture deficiency. Forest capability for lodgepole pine averages 30 to 50 cubic feet per acre annually. The deep, sandy soils of the Henning series have forest capabilities of more than 50 cubic feet.

One map unit was established in the Tulameen area.

HENNING

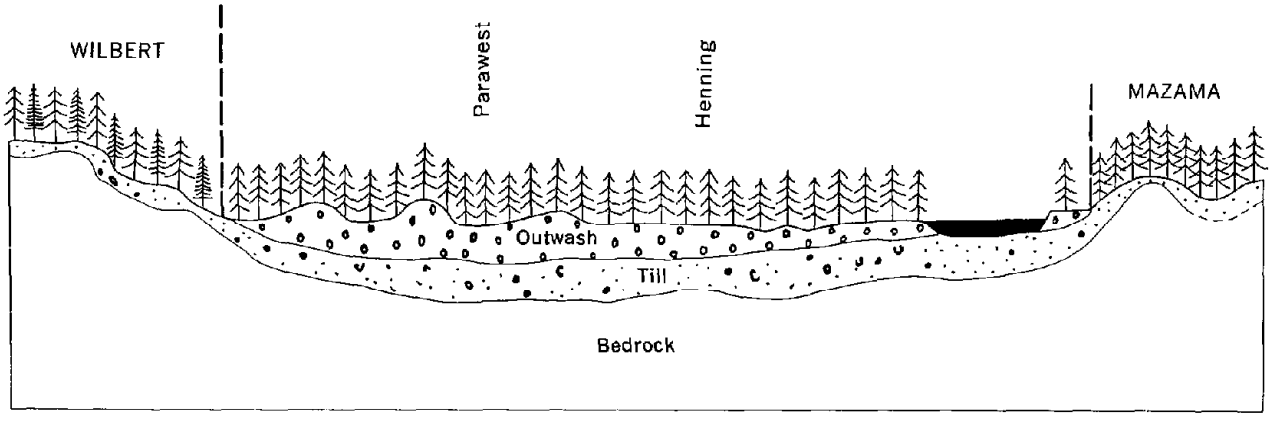


Figure 15. Stand of lodgepole pine on Henning sandy loam, an Orthic Dystric Brunisol. Annual growth is 30 to 70 cubic feet per acre.

Henning (HE)

This unit contains 70% to 80% Henning series. The remaining 20% to 30% is mainly Parawest series. These soils have limited use for grazing by cattle and wildlife. The forestry potential is low. Henning soils that border Pennask Lake have moderate capability to support fishing and camping activities. About 15,700 acres were mapped.

The Pasayten Map Unit

The Pasayten catena consists mainly of Podzolic soils developed on coarse textured outwash and stream deposits. These soils occur at elevations of 3700 to 4300 feet in the valleys of the Coldwater and Coquihalla rivers. They cover 700 acres.

The gravelly sandy loam parent material is strongly acidic. The topography is mainly gently sloping, but the land surface is frequently dissected by channels. The plant communities contain trees and shrubs of the coastal hemlock zone. Mountain hemlock, western red cedar, amabilis fir, and lodgepole pine are common trees; ground cover plants include red-osier dogwood, blueberries, bunchberry, false-box, and mosses.

The Pasayten catena is dominated by Pasayten series, a Mini Humo-Ferric Podzol.

Pasayten series is a well-drained, permeable soil with organic litter horizons (L–H) overlying a thin leached horizon (Ae) over yellowish brown lower horizons (Bf, BC) that lie on acidic gravelly loamy sand.

Small amounts of gleyed Podzolic and Brunisolic soils are included in the catena.

Climate and stoniness are the chief limitations to agriculture on Pasayten soils.

Pasayten soils have only slight limitations for the growth of Engelmann spruce and lodgepole pine. The annual productivity of these trees is 70 to 110 cubic feet per acre.

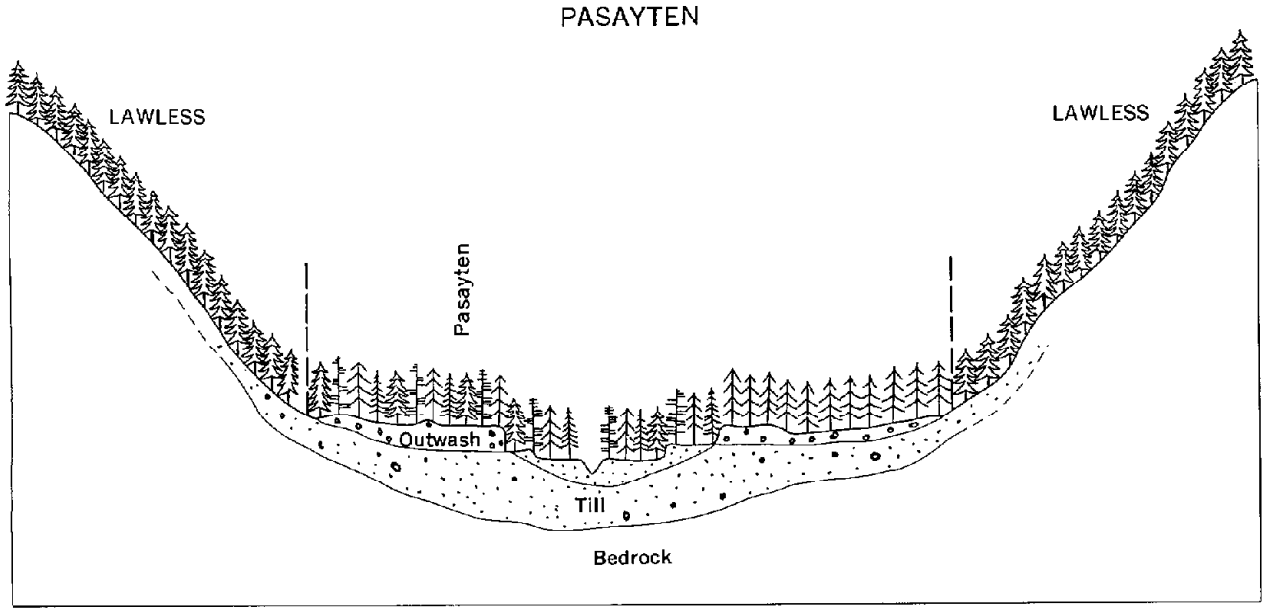
One map unit was established in the area.

Pasayten (PY)

This unit contains about 70% Pasayten series and 20% to 25% Henning series. Gleyed soils occupy depressions. The main use of this soil unit is for forestry. About 700 acres were mapped.

The Trehearne Map Unit

The Trehearne complex consists of Brunisolic, Chernozemic, and Luvisolic soils. The complex occurs on channel deposits of gravels, sands, and silts in the northern



part of the area. Elevations range from 3700 to 4000 feet. About 3200 acres were mapped.

Soils have developed on lag and channel bottom gravels and sands, on ponded silts, and on minor inclusions of till. Soil reaction is mildly alkaline. The topography ranges from gently and moderately sloping to steeply sloping on an irregular hummocky landform (Figure 16).

The vegetation consists mainly of a fairly dense forest of Douglas-fir, lodgepole pine, pine grass, kinnikinnick, and forbs. Open forest and grassy openings contain bunch grasses and forbs of the grassland plant communities.

The Trehearne complex contains the Trehearne (Degraded Eutric Brunisol), Hastings (Orthic Dark Gray), Shinish (Orthic Gray Luvisol), and Allison (Orthic Black) soil series.

Trehearne, the dominant series, is a well-drained soil that has rapid infiltration, rapid permeability in the upper horizons, and moderate permeability in the subsoil. The soil is generally stone-free, but areas of gravelly sand occur. The topography ranges from gently to steeply sloping. The profile has very thick (up to 30 inches) leached horizons (Ae), brown loamy sand horizons (Bm), and thick lower horizons that contain several fine bands or layers (BA, Btj). A calcareous loamy sand horizon (Ck) usually occurs at depths of 7 feet or more.

Hastings soils have a profile similar to that of the Trehearne series, but lack the thick leached Ae horizons. Chernozemic surface horizons (Ah, Ahe) occur under the grasses and forbs.

Shinish is a well-drained soil series that has developed on stratified silt and fine sand. It occurs in small ponded basins on gently to moderately sloping topography. The vegetation is a fairly dense Douglas-fir – pine grass forest. Shinish soils have thin litter horizons (L–H), thick leached horizons (Ae), and strongly developed subsoil horizons (Bt).

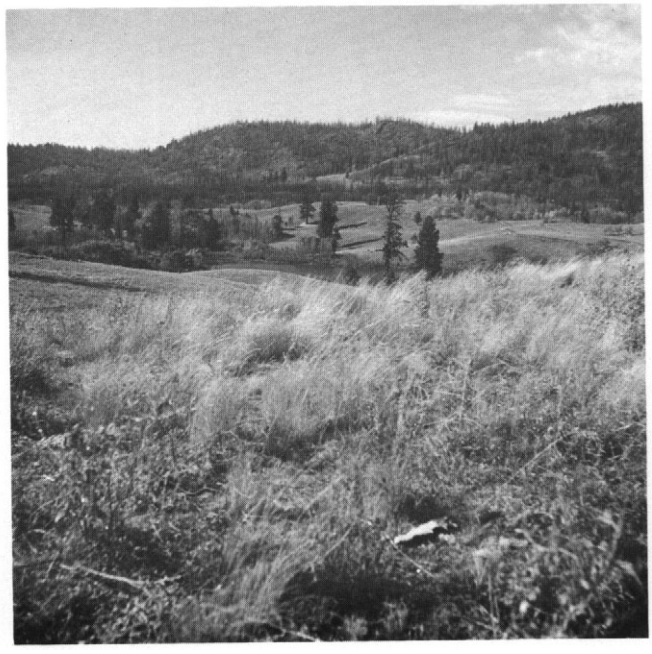


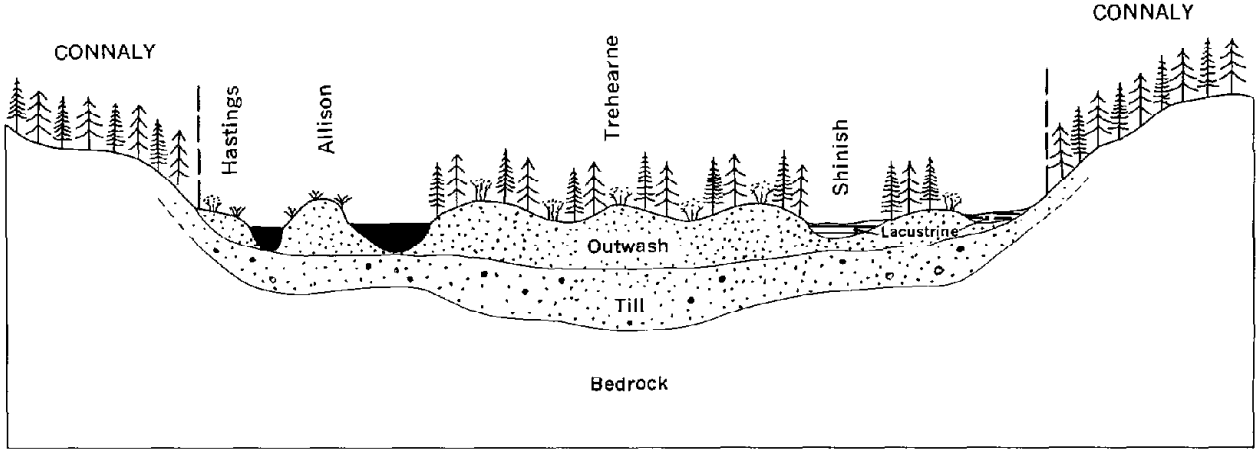
Figure 16. Landform typical of the Trehearne map unit.

Allison soils have developed under grassland vegetation. They are rapidly drained and highly permeable.

Limitations of climate, low moisture-holding capacity, stoniness, and topography restrict agricultural use of the Trehearne, Hastings, and Allison series to grazing and to a limited range of perennial forage crops. The heavier textured Shinish soils occur only as small unmanageable units in the complex.

The low moisture-holding capacity of most soils in the complex limits the annual growth of Douglas-fir, lodge-

TREHEARNE



pole pine, and ponderosa pine to less than 50 cubic feet per acre. Shinish soils can produce up to 70 cubic feet of wood. Allison soils have no forest capability. Trehearne soils in the Kentucky Lake vicinity have a moderately high capability for outdoor recreation.

Two map units were established in the Tulameen area.

Trehearne 1 (TR 1)

This unit contains about 60% Trehearne and 20% each of Hastings and Shinish series. It has value for grazing by domestic stock and wildlife. Forestry use is limited. About 2000 acres were mapped.

Trehearne 2 (TR 2)

This unit contains 60% Trehearne and 40% Allison series. It is grazed by cattle and deer and has limited use for forestry and improved pasture. This unit has a moderately high capability for outdoor recreational activities, such as fishing, boating, and camping. About 1200 acres were mapped.

SOILS ON ALLUVIAL DEPOSITS

The Bluey, Manning, Riddell, Iltcoola, and Thalia soil units, which are developed on recent alluvial and fan deposits, comprise only about 1.5% of the area, but they include most of the important agricultural soils. The soils are mainly weakly developed Chernozems, Brunisols, Regosols, and Gleysols.

The Bluey Map Unit

The Bluey catena consists of heavy textured, mainly Gleysolic soils that developed on recent alluvium. The main map units occur in the Otter Valley at elevations of 2600 to 2900 feet. The Bluey soils cover about 1600 acres.

The neutral to slightly alkaline alluvial parent material occurs on depressional and very gently sloping land, often adjacent to old beaver dams. The native vegetation is sedges, reeds, manna grass, willows, and cottonwood of wetland plant communities.

The Bluey catena consists of the Bluey (Low Humic Eluviated Gleysol) and Thynne (Rego Humic Gleysol) soil series.

Bluey, the dominant series, is poorly drained and very slowly permeable. The profile has 6 inches of dark brown clay loam (Ap) and a mottled sandy clay loam horizon (Btjg) over calcareous gleyed parent material (Ckg).

Bluey soils are associated with the Manning series.

Thynne soils are poorly drained and slowly permeable. They have thick dark brown surface horizons (Ap, Ah) over mottled sandy clay (Cg) that rests on loose sand and gravel (IIC) at 30 inches.

Excessive wetness as a result of flooding and seepage, and unfavorable soil structure restrict agriculture on Bluey and Thynne soils to coarse grains, hay, and forage crops. These soils have no capability for forestry except for the production of cottonwood.

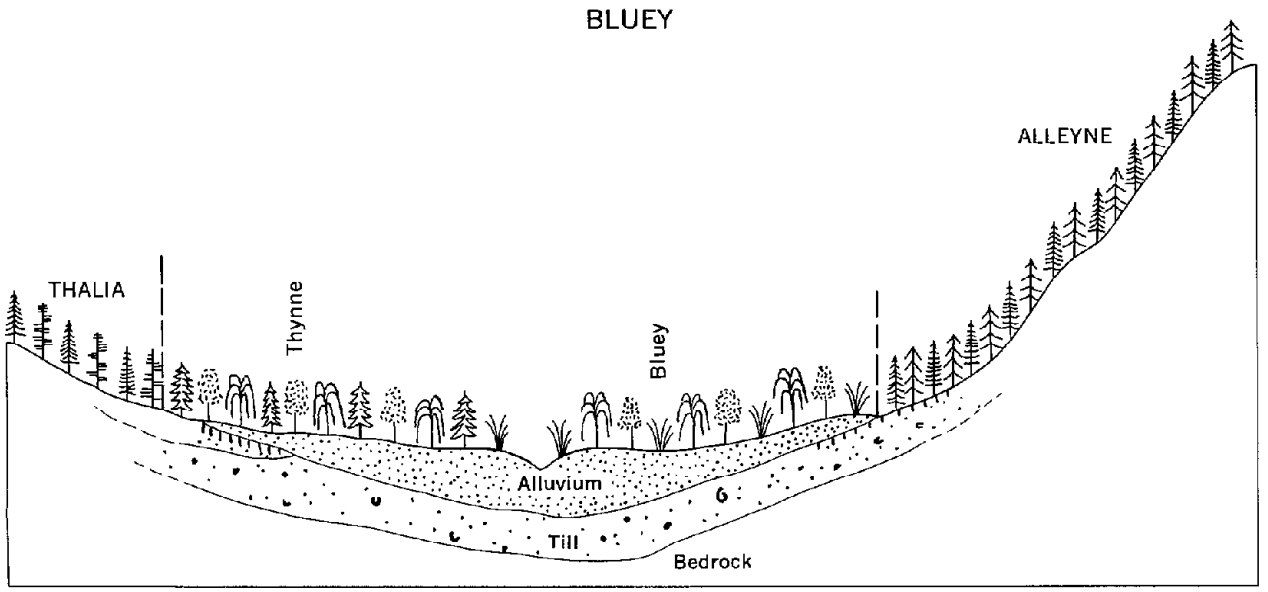
One map unit occurs in the area.

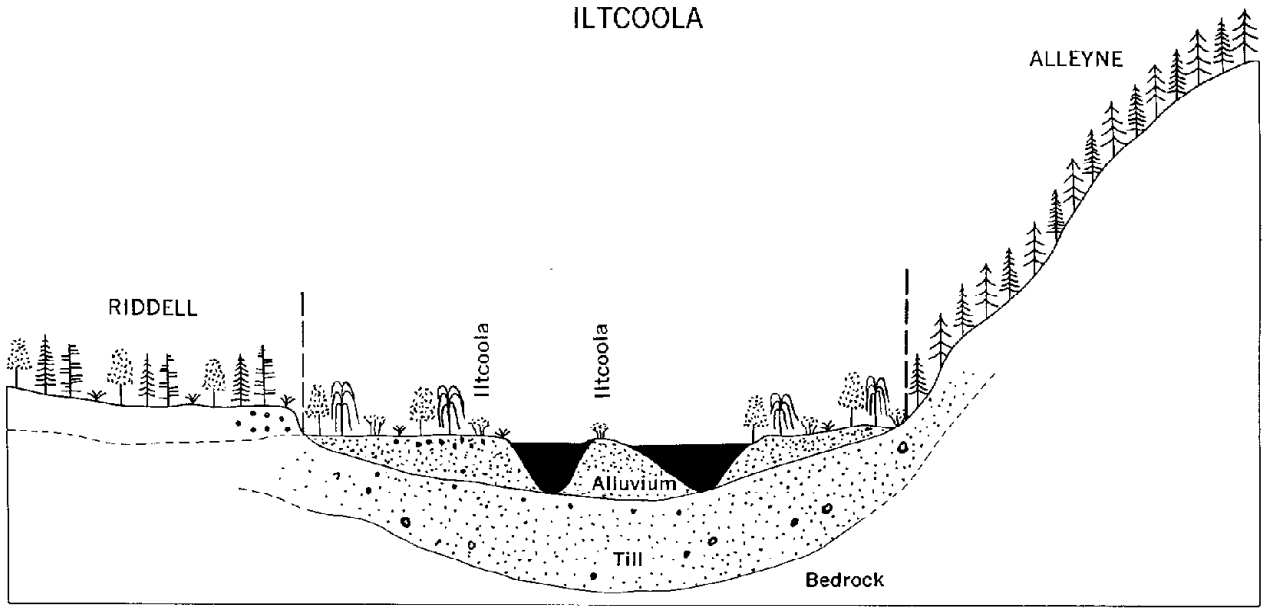
Bluey (BY)

This unit contains 60% Bluey series and 40% Thynne series. A small acreage in the Otter Valley has been drained for hay and pasture production. Most of the soils are used for grazing by livestock and wildlife. About 1600 acres were mapped.

The Iltcoola Map Unit

The Regosolic soils of the Iltcoola complex occur along major streams east of the Cascade Mountains. The parent materials are recently deposited, weakly calcareous sands and gravels of river bars and gently sloping lower terraces. Inundation by spring freshets is common, and the fluctuat-





ing water table is generally near the surface. The topography is nearly level to gently sloping. The complex covers only 68 acres in the Tulameen area. Elevations range from 2500 to 3600 feet.

The native vegetation is an unstable community of trees, shrubs, forbs, and grasses. It is generally dominated by cottonwood and willows.

The Iltcoola complex consists of the Iltcoola (Gleyed Orthic Regosol) soil series and variable amounts of Cumulic Regosol and Orthic Regosol soils.

Iltcoola is the dominant soil. This imperfectly drained loamy sand is characterized by fairly thick litter horizons (L–F) and 6 inches of grayish brown surface horizon (Ah) over gleyed, mottled loamy sand (Cg) and cobbly gravel (IIC).

Stoniness and frequent flooding restrict agricultural use of the soils to grazing and unimproved pasture.

Soils on the better-drained, more stable terraces have a limited suitability for Engelmann spruce, Douglas-fir, and ponderosa pine. Annual growth averages 50 to 70 cubic feet per acre. The lower terraces, which are frequently inundated, support vigorous stands of black cottonwood.

One unit was established in the area.

Iltcoola (IL)

This map unit, dominated by the Iltcoola series, may contain 15% to 30% of Cumulic and Orthic Regosols. The soils are of little use for agriculture or forestry except for cottonwood harvesting. They provide a local source of gravel. Only 68 acres were mapped in the area.

The Manning Map Unit

The Manning catena consists of Gleysolic soils developed on moderately fine textured alluvial deposits of the major rivers and streams. The elevation ranges from 2400 to 2900 feet. About 3200 acres were mapped.

The parent material is stone-free, moderately alkaline, sandy clay loam alluvium on very gently sloping terraces and fan aprons. The native vegetation is dominated by moisture-loving plants, such as cottonwood, willows, and Kentucky blue grass.

The Manning catena is dominated by Manning soils, which are Humic Eluviated Gleysols.

Manning soils are imperfectly to poorly drained. Although a high water table restricts drainage for most of the year, the soils have moderate permeability. The soil profile has thick, grayish brown sandy loam and sandy clay loam surface horizons (Ap, Ahe) over mottled horizons (Btg, Ckg) that overlie loose sand and gravel (IIC).

Manning soils are associated with the Bluey, Thalia, and Coley series.

Riddell soils occupy the better-drained positions above Manning soils.

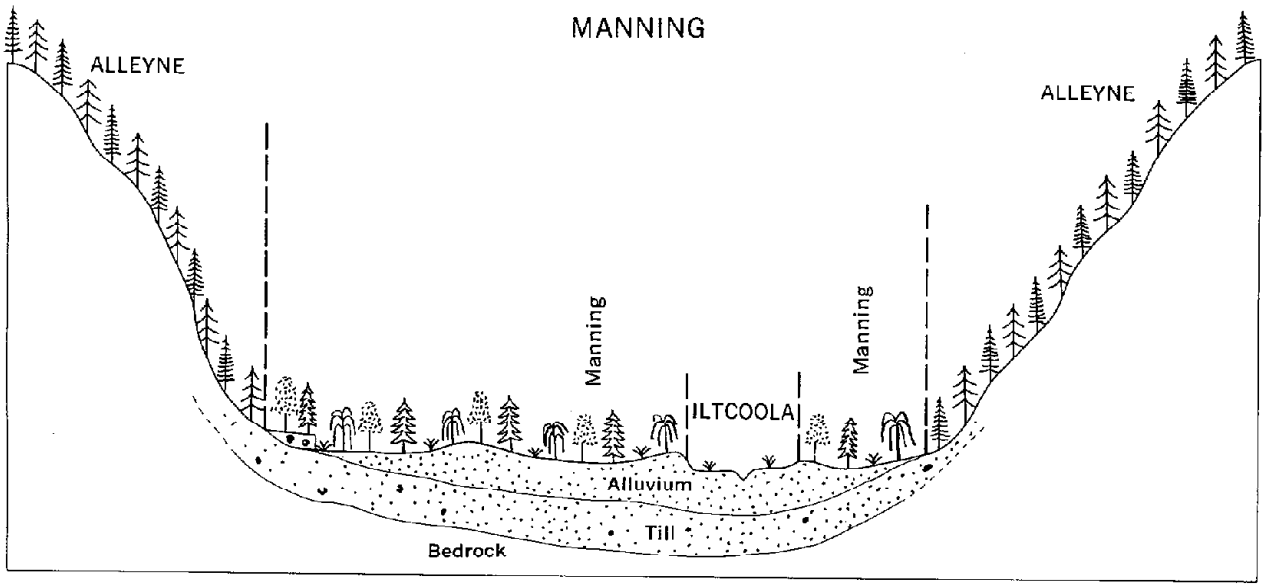
Soils of the catena have only moderate climatic restrictions for agriculture. Manning soils are generally limited by excessive moisture in the form of seepage or inundation. They can support only a few annual and perennial field crops. When drained and irrigated, they can produce sustained yields of grains and forage crops.

The Manning series has moderate limitations for forestry. The soils are best suited to spruce, which has an annual growth of 70 to 90 cubic feet per acre.

One map unit was established.

Manning (MA)

This unit contains 80% Manning and 20% Riddell series. A small acreage has been cleared and drained, but most of the unit is used as native pasture for livestock and wildlife. Much of it has a moderate potential for crop production and logging of spruce. About 3200 acres were mapped.



The Riddell Map Unit

The Riddell catena consists of Dark Gray soils developed on moderately coarse and medium textured alluvium. The soils occur on gently and moderately sloping terraces of the major rivers and their tributaries. Elevations range from 2400 to 2900 feet. The soils of the catena cover about 6000 acres.

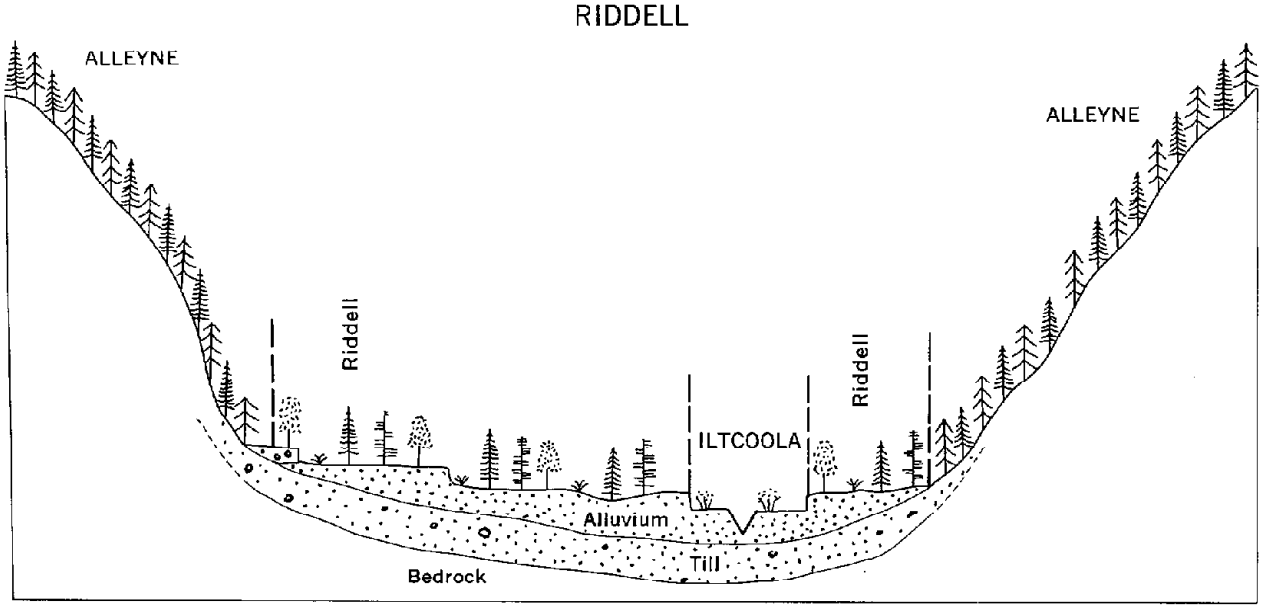
The parent material is moderately alkaline, sandy loam alluvium on very gently sloping terraces. The native vegetation consists of unstable plant communities dominated by trembling aspen and Kentucky blue grass, with scattered Douglas-fir and ponderosa pine.

The Riddell catena is dominated by the Rego Dark Gray Riddell soil series.

Riddell soils are well drained and permeable in all horizons. The soil profile is generally stone free, mildly alkaline, and moderately coarse textured. Riddell soils have thin surface horizons (Ah) over grayish brown sandy loam (Ahe) and loamy sand horizons (Ck) with free lime accumulation at depths of 15 to 30 inches. A substrate (IIC) of sand and gravel commonly occurs at depths of 20 to 36 inches.

Riddell soils are associated with soils of the Manning and Iltcoola series.

Deep, gently sloping, fine sandy loam Riddell soils have no soil limitations to crop growth under irrigation. The regional climate slightly restricts the annual crops that can be grown. Most Riddell soils have some texture or topo-



graphic limitations that further limit their capability for agriculture.

Aridity is the main limitation to the forest capability of Riddell soils. The average annual production is between 50 to 70 cubic feet of wood per acre.

One map unit was established.

Riddell (RI)

This map unit contains 70% to 80% Riddell and 20% to 30% Manning series. Almost the entire acreage of arable Riddell soils supports crops under irrigation. The unit has a moderate capability for forestry.

Soils of the Riddell unit in the Coldwater and Tulameen valleys have a moderate capability for outdoor recreation. Camping, fishing, and viewing sites occur in the units. About 6000 acres were mapped.

The Thalia Map Unit

The Thalia complex consists of Brunisolic and Gray Luvisol soils developed on very coarse to moderately fine textured fans. These soils cover about 4000 acres in the main valleys at elevations of 2300 to 3200 feet.

The textures of the parent materials range from gravelly loamy sands to sandy clay loams that overlie moderately alkaline cobbly gravels. Fan surfaces are moderately to strongly sloping. The native vegetation is mainly Douglas-fir and lodgepole pine with some ponderosa pine and a ground cover of pine grass, kinnikinnick, sedges, and spirea.

The Thalia complex consists of the Thalia (Degraded Eutric Brunisol) and Bromley (Orthic Gray Luvisol) soil series.

Thalia, the dominant soil, is well to rapidly drained and rapidly permeable. It has thin litter layers (L–H), grayish brown loamy sand horizons (Aej), and gravelly sandy loam horizons (Bm) that overlie gravel at depths of 10 to 20 inches. These soils commonly occupy the upper slopes and apex positions of fans.

Thalia soils are associated with the Bromley, Asp, and Riddell series.

Bromley soils are well drained and moderately permeable. The profile has thick, grayish leached horizons (Ae), transitional horizons (AB, BA), and a gravelly sandy clay loam horizon (Bt). Calcium carbonate occurs at 3 feet. Bromley soils generally occur on lower slopes of fan aprons.

Soils of the Thalia complex have moderate climatic limitations, but have severe limitations of stoniness, low moisture-holding capacity, and adverse topography. Most of the soils are restricted to forage crop production under irrigation or to native pasture.

Soils of the Thalia and Bromley series produce 10 to 50 cubic feet per acre annually of Douglas-fir and lodgepole pine.

The soils provide some early spring pasture and wintering sites for mule deer.

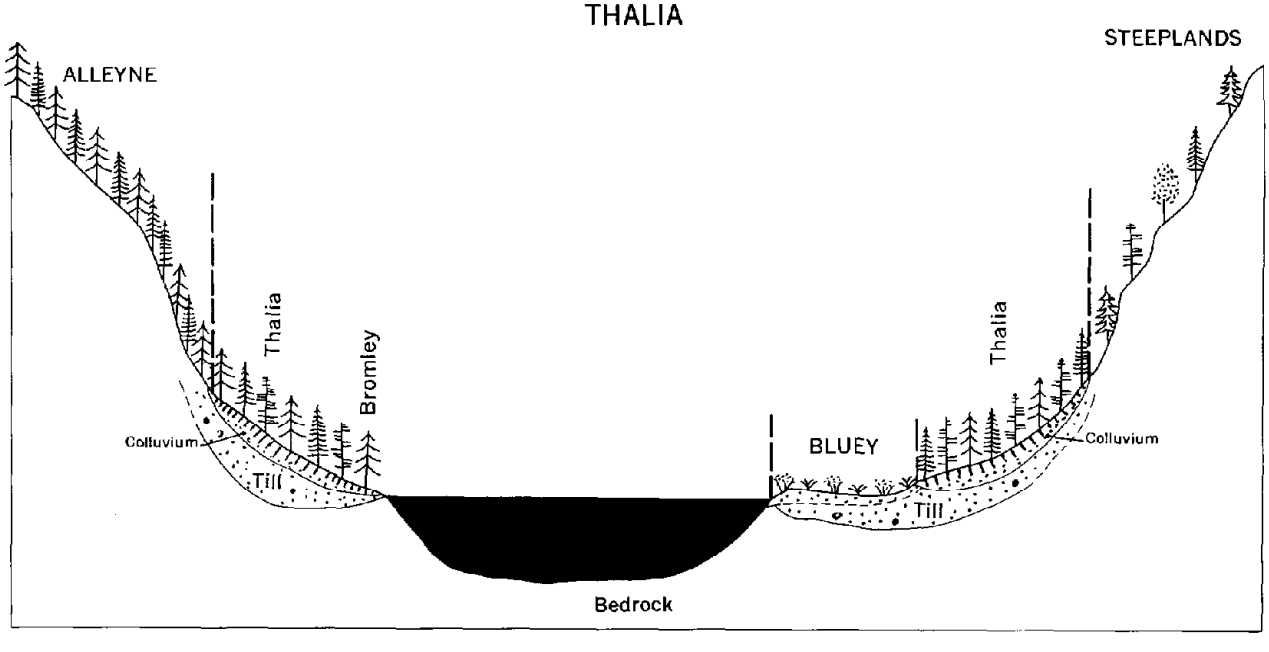
One map unit was established in the area.

Thalia (TH)

This unit contains about 80% Thalia and 20% Bromley series. These soils occur mainly in the Hayes, Trout, Allison, and Otter valleys on small fans associated with outwash materials. They are mainly used for livestock and wildlife grazing. A small acreage is irrigated for hay production. About 4000 acres were mapped.

SOILS ON ORGANIC MATERIALS

The two organic soil complexes, Coley and Etches, together occupy about 1% of the area. They are widely distributed as small units throughout the plateau from valley bottoms up to the alpine.



The Coley Map Unit

The Coley complex consists of Organic soils developed on slightly to moderately acid organic accumulations. These soils occur as small isolated units throughout the lower plateau at elevations of 3500 to 4500 feet. They cover about 5000 acres.

The soils have developed from decomposed aquatic plants, sedges, reeds, and shrubs that have accumulated in shallow depressions and channel fillings. The native vegetation is dominated by sedges and grasses. The typical plants are beaked sedge, reed grass, redtop, tall manna grass, and willows. Topography is depressional to very gently sloping.

The Coley complex consists of the Coley series (Typic Mesisol), Terric Mesisols, and Gleysolic soils.

Coley soils are very poorly drained. They have 6 to 8 inches of very dark brown, slightly alkaline surface layers of roots and leaves over dark brown semidecomposed plant remains.

Accumulations of marl frequently overlie the surface layers or are incorporated in the surface tier. A thin stratum of volcanic ash commonly occurs at depths of 12 to 18 inches from the surface.

Most Coley soils have some natural sustained grazing capacity. In places where drainage is improved these soils can support coarse grains, forage crops, and hay (Figure 17).

Coley soils are limited by excessive wetness to an annual tree growth of less than 10 cubic feet per acre.

One unit was recognized in the surveyed area.

Coley (CY)

This unit contains 60% to 80% Coley series and 20% to 40% Terric Mesisols and Gleysolic soils. It is used for late summer grazing by stock and for native hay production. About 5000 acres were mapped.

The Etches Map Unit

The Etches complex consists of Organic soils developed on strongly acid organic materials. The soils occur in the upper plateau from elevations of 4500 feet up into the alpine region. They cover about 7200 acres.

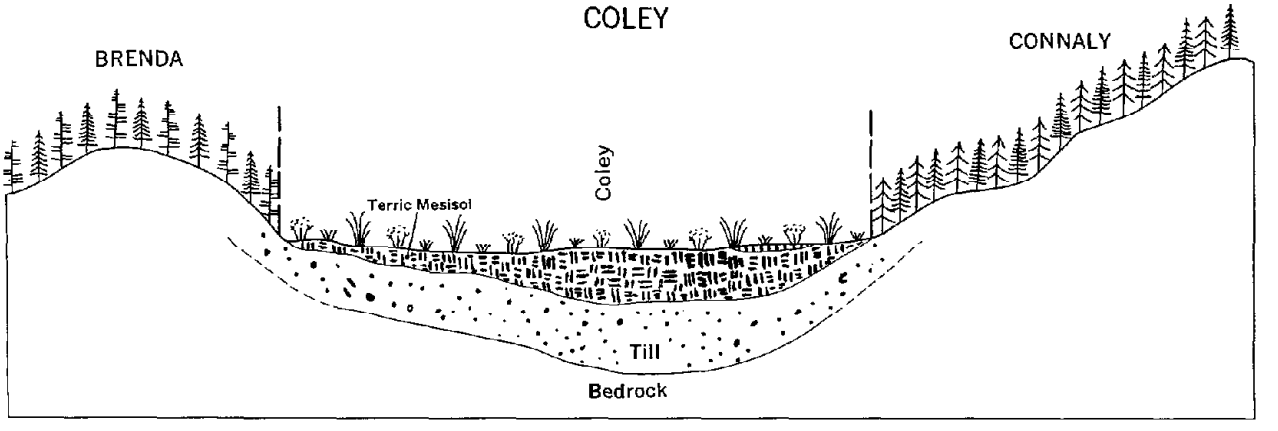
Figure 17. Coley peat, a Typic Mesisol, supports grazing and native hay crops.

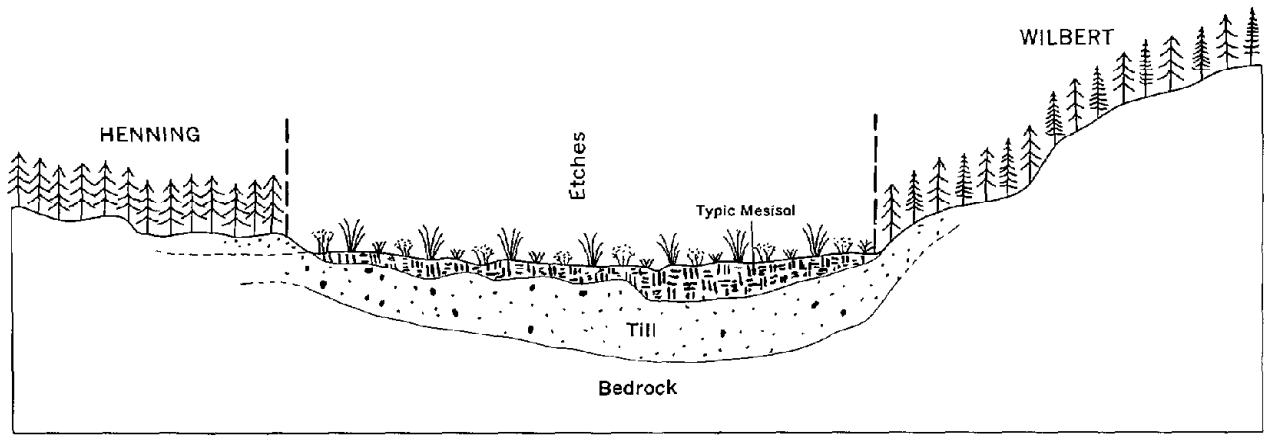
The partially decomposed organic materials are derived mainly from sedges and other aquatic plants. The strongly acidic plant remains are usually over 2 feet thick. Sedges dominate the native vegetation. Other plants include willows, Labrador tea, and scattered trees and shrubs along the margins of the bogs The topography is nearly level and depressional.

The Etches complex consists of Etches series (Typic Mesisol), Terric Mesisols, and Gleysolic soils.

Etches soils are very poorly drained. The profile has 5 to 6 inches of fine roots, leaves, and semidecomposed plant fiber (f) over dark brown, decomposed organic remains (m). At 24 inches fine sand layers commonly occur.

Limitations of climate and excessive wetness restrict Etches soils to native grazing by wildlife and domestic stock.





Etches soils have a forest capability of less than 10 cubic feet per acre annually. Large units of organic soils near Pennask Lake serve as wintering grounds for moose.

One map unit was established in the surveyed area.

Etches (ET)

This unit contains 60% to 80% Etches series and 20% to 40% Terric Mesisols and Gleysolic soils. It is used mainly as browse by deer and moose and to a limited extent by domestic stock. About 7200 acres were mapped.

LAND TYPES

Two land types, Steeplands and Rock Outcrop, were recognized. Steeplands occupy about 6% of the area. Rock Outcrop was delineated as a single map unit on Mt. Thynne, but this land type is an important component of several map units.

Rock Outcrop

The Rock Outcrop land type consists of exposures of bare rock or rock covered by 4 inches or less of mineral or organic soil. One unit of 400 acres was mapped separately. Other small units are shown in complex with soil units.

The units mainly occupy glacially abraded ridge tops or knolls. Other units occur as outcrops on steep sideslopes or as cliffs and walls of canyons. Talus slopes are included in the Rock Outcrop land type. Vegetation is sparse or absent.

Rock Outcrop is associated with many of the upland soils, such as the Selish, Coalmont, Kane, Kullah, Bankeir, Miner, Alleyne, Darcy, Bonnevier, and Skaist soil series, and the Steeplands land type.

Rock Outcrop has no agricultural or forestry capability. It may provide grazing and shelter for wildlife.

One map unit was established.

Rock Outcrop (R)

This unit contains 90% or more of bare rock. It has no value for agriculture or forestry. The chief uses are for watershed protection, wildlife, and recreation. About 400 acres were mapped.

Steeplands

The Steeplands land type consists of very steeply sloping land that contains undifferentiated Regosolic and Brunisolic soils developed on colluvial, till, and outwash materials. The unit covers about 60,000 acres.

The Steeplands unit occupies very steep and extremely steep sideslopes of eroded valleys, meltwater channels, and mountain slopes. Gradients are more than 30% and usually exceed 60%.

These slopes have a sparse cover of shrubs, grasses, forbs, and trees.

Steeplands are associated mainly with Alleyne soils.

Steeplands have no agricultural or forestry capability. The unit has value as browse and wintering habitat for mule deer.

One map unit was recognized in the Tulameen area.

Steeplands (SL)

This unit contains a high percentage of bare rock and Regosolic soils. Brunisolic soils occupy some protected draws and more level sites. This land type has value for wildlife and watershed protection.

Steeplands should not be logged or disturbed by road construction. About 60,000 acres were mapped.

USE AND CAPABILITIES OF SOILS

The soils of the Tulameen area are used to produce agricultural crops and timber, to provide forage for livestock, browse and shelter for wildlife, and to provide opportunities for recreation. Some or all of these uses may occur together on the same unit of land.

This section of the report describes the use and capabilities of the soils and map units for each land use sector. The information and the amount of detail concerning each use varies greatly. Because the soils of the main valleys and lowlands were initially mapped and rated for irrigation

potential, most of the available information concerned agricultural capability. The ability of the soils to produce commercial timber was determined by measuring growth plots on each soil series. Wildlife and recreation capabilities were assessed on the broader basis of the map units.

SOILS AND AGRICULTURAL CAPABILITY

The soil capability classification is an interpretive grouping of the soils of the area. It groups soils into seven classes on the basis of their suitability and limitations for agricultural use (Canada Land Inventory Report No. 2 1965). Soils of Class 1, 2, and 3 are suited to sustained production of common field crops. Class 4 soils are marginal for arable agriculture. Soils of Class 5 and 6 are limited to use for permanent pasture. On Class 5 soils, improvement practices are feasible, but soils of Class 6 are restricted to wild pasture. Class 7 soils cannot support use for arable agriculture or pasture. The soils in all of these classes may be suitable for forestry, wildlife, or recreation. Soils of the Tulameen area are rated Class 2, 3, 4, 5, 6, and 7 (Table 3).

This capability classification assumes that soils within a class are similar in the degree but not in the kind of limitations. Soils capable of improvement by draining, irrigation, removing stones, or protection from overflow are classified according to their continuing limitations or hazards in use after the improvements have been made. Distances to markets, kinds of roads, location, size of farms, characteristics of landownerships, and the skill or resources of individual operators are not criteria for capability groupings.

Capability Subclasses

The climatic, soil, and landscape limitations applied to soils in the Tulameen area are as follows:

Climatic limitations

Climatic limitations for the Tulameen area (Marshall 1970) are based on adverse subregional climate, where climate is the only limitation. Elevation ranges for climatic classes were estimated by extrapolating climatic data from stations in valleys and plateaus outside the area. Below elevations of 3000 feet, droughtiness is the main limitation. Above 3000 feet, the length of the frost-free period and number of growing degree-days are limitations. The 3C climate extends up to about 4000 feet on uplands and southerly aspects of valley slopes.

Location (feet above sea level)	Frost-free period (days)	Growing degree-days	Basic climate	Climatic Class	
				dry-farmed	irrigated
Valleys to 2900	> 90	> 2150	1	3C	1C
Valleys 2900–3300	75–90	1900–2150	2	3C	2C
Plateaus 3300–3800	60–75	1650–1900	3	3C	3C
Plateaus 3800–5500	< 50	1200–1650	5	5C	5C
Upper plateaus 5500–6800	< 50	< 1200	6	6C	

Table 3. Soil capability for agriculture ratings in the Tulameen area

Map unit	Class 3* acres	Class 4* acres	Class 5* acres	Class 6 acres	Class 7 acres	Total acreage
Alleyne				6,050	35,500	41,550
Asp		410	1,770	4,040		6,220
Bluey		1,090	340	220		1,650
Bonnevier				1,770		1,770
Brenda		710	80	8,080		8,870
Britton 1			17,000	26,900	18,400	62,300
Britton 2			8,010	11,700		19,710
Coley		3,460		1,300		4,760
Connaly 1		5,300	43,600	67,100		116,000
Connaly 2			3,370	11,600		14,970
Eastmere					570	570
Etches			1,310	370	5,430	7,110
Fairweather			4,630			4,630
Galena		2,360	230	260		2,850
Grant			4,180			4,180
Henning			9,500	6,250		15,750
Howarth	1,840			5,260		7,100
Iltcoola				70		70
Lawless 1				710	117,800	118,510
Lawless 2					13,300	13,300
Lawless 3					7,370	7,370
Manning	810	1,100	950	350		3,210
Mazama				8,360	113,300	121,660
Midday	1,630		70			1,700
Pasayten					700	700
Princeton		200	4,680	280		5,160
Riddell	3,240	2,490	180	120		6,030
Rock Outcrop					400	400
Steeplands				3,110	56,000	59,110
Thalia		100	2,830	1,080		4,010
Trehearne 1				1,960		1,960
Trehearne 2				1,200		1,200
Tulameen		3,920				3,920
Wilbert				7,120	300,280	307,400
Acres in each class	7,520	21,140	102,730	175,260	669,050	
Percentage of the total acreage	0.7	2.1	10.4	17.7	69.1	
Water						14,700
Total area						990,400

*Improved ratings (irrigation and/or drainage).

Soil limitations

In the Tulameen area, three subclasses were used to designate unfavorable soil characteristics:

Subclass M—inadequate soil moisture-holding capacity; used for coarse textured outwash soils.

Subclass D—poor structure and permeability; used for poorly drained mineral soils.

Subclass F—low soil fertility; used for organic soils and for very coarse textured soils.

Landscape limitations

Adverse landscape features are the main limitations of soils of the Tulameen area. These limitations are:

Subclass T—unfavorable topography

Subclass P—excess stoniness

Subclass R—shallowness to bedrock

Subclass W—excess water (excluding inundation)

Subclass I—inundation (flooding)

Subclass X—cumulative minor adverse characteristics

Adverse topography (T) is a limitation on smooth, greater than 5% slopes and on irregular, rolling land, where the capability is reduced by one or more classes. This subclass is the main limitation of soils developed on till and colluvial deposits. Excess stoniness (P) was used on outwash soils, and shallowness to bedrock (R) was applied to lithic soils. An adverse water limitation (W) was applied to the Gleysolic and Organic soils. The flooding limitation (I) was applied only to recent river gravels. The minor cumulative limitation (X) was used on some high-capability soils.

In evaluating the capability of a soil, the local climate is considered first. Subclass limitations of soil and landscape are then applied. Thus, a stony, medium textured soil with no adverse soil properties, on strongly sloping topography, in a Class 3 climatic zone may be reduced from Class 3 to Class 5 (map symbol: 5PT). In this case, the rating for irrigated farming is the same as the rating for dry farming. A comparison of the soil capability for agriculture ratings of the soils of the Tulameen area is given in Table 3.

A moisture deficit of up to 8 inches during the growing season in the valleys of Hayes and Allison creeks and the Coldwater River makes irrigation necessary for most agricultural crops. Almost all of the irrigable soils lie in the Class 2 and 3 climatic zones, and a small amount is in the Class 1 zone. Soil moisture deficiency and excess stoniness are the main limitations on soils of the Riddell, Manning, Princeton, Asp, Galena, and Thalia catenas. Adverse topography and minor cumulative soil factors limit the medium textured Howarth soils.

Above 3800 to 4000 feet, the short frost-free period and the low number of growing degree-days restrict the soil capability to the production of perennial forage crops. Almost 95% of the soils of the area are in this Class 5 climatic zone. The soils are also limited by topography, stoniness, and rockiness.

SOILS AND FORESTRY CAPABILITY

by

M. J. Romaine and T. M. Lord

The senior author undertook the Canada Land Inventory land capability for forestry survey of the Tulameen map sheet area. Table 4 shows the capability classes and the physical limitations of each soil series and land type and the suitability of four tree species.

Forest productivity ratings were based on the seven-class forest capability system (McCormack 1970) of the Canada Land Inventory in which Class 1 is the highest rating and Class 7 the lowest. Under the land capability for forestry system, all soils and land types are grouped into one of seven classes, based upon their inherent ability to grow commercial timber. Class 1, 2, and 3 soils have no limitations or moderate limitations to the growth of commercial forests. Class 4 soils have moderately severe limitations. Class 5 and 6 have severe limitations and Class 7 soils have very severe limitations that preclude the growth of commercial forests. Such factors as distance to markets, access, location, size of units, and ownership are not considered in the system.

The rating for each soil was based on stand volume data from a uniform area representative of the main soil series and land types identified during the soil survey. When plot data were not available, the rating was based on observed information about the soil, including subsoil, soil profile, depth, moisture, and landform. In general, the stands selected for measurement were thrifty, fully stocked, composed of one species, and near the rotation age of 80 to 100 years. The mean annual increment (MAI) ranges listed for each class are based on a rotation age of 100.

Wherever possible, a single forest capability rating was applied to each soil series or land type. However, two or more classes were assigned to soils if their productivity covered more than one capability class because of minor variations in drainage conditions, depth of soil, and soil texture, which could not be delineated because of the scale of mapping.

The limiting factors indicate the nature of the limitations to forest growth. Major limitations in the surveyed area include soil moisture deficiency or excess, soil permeability, depth of rooting zone, and exposure.

Tree species were categorized as suitable, not suitable, or of limited suitability for each soil series or land type, according to the characteristics of each soil and the silvics of each tree species (Table 4). Only those species of present commercial value now growing or expected to grow were considered.

The highest capability classes for commercial timber production occur mainly on soils of the Lawless and Wilbert map units. The parent materials are coarse textured, slightly acid colluvial and till deposits. The soils are mainly deep, sandy loams that are well, moderately well, and imperfectly drained. They receive a continuous supply of upslope telluric waters during the growing season. These Podzol, Brunisol, and Gleysol soils occur under cool, moist conditions in mountain valleys or on protected north-facing slopes of the plateau. The main soil series are Lawless, Nicomen, Wilbert, and Pefferle. Lacustrine soils of the Eastmere map unit and alluvial soils of the Manning and Pasayten units have moderately high forest capabilities. Class 1, 2, and 3 soils that have an annual productivity of 70 to more than 110 cubic feet per acre cover about 17% of the surveyed area. Engelmann spruce and lodgepole pine are the most suitable species.

Moderate forest capabilities occur chiefly on moderately coarse and medium textured, neutral to slightly alkaline tills. The soils developed on these parent materials belong to the Connaly, Grant, Mazama, and Tulameen map units. Main limitations to tree growth are soil moisture deficiency and some adverse soil structure that affects root penetration. The main soil series in this capability group are Connaly, Grant, Mazama, and Tulameen, which belong to the Gray

Table 4. Forestry interpretations for the Tulameen area

Soil series or land type	1. Capability class	2. Limiting factors	3. Species suitability: lodgepole pine	Engelmann spruce	Douglas-fir	Ponderosa pine
Alleyne	5,6	M,A	LS	NS	LS	LS
Allison	7	A,M	NS	NS	NS	NS
Asp	5–7	M	NS	NS	LS	S
Bankeir	5–7	M,R	S	NS	LS	NS
Bluey	7	W	NS	NS	NS	NS
Bonnevier	7	H,R	NS	LS	NS	NS
Boot	3,2	M,S	S	S	NS	NS
Brenda	6,7	A,M	NS	NS	NS	LS
Britton	5,4	M,D	LS	NS	LS	LS
Bromley	5,4	M,D	NS	LS	LS	LS
Bull	4,3	D	S	S	NS	NS
Chuwanten	7	H,W	NS	NS	NS	NS
Coalmont	5	M,D	LS	NS	LS	S
Coley	7	W	NS	NS	NS	NS
Collett	7	W	NS	NS	NS	NS
Connaly	4,3	M,D	S	LS	S	NS
Coquihalla	2,3	M,S	S	S	NS	NS
Corbett	6,7	M	NS	NS	NS	LS
Darcy	5–7	M,A	NS	NS	NS	S
Eastmere	3,2	M,S	S	S	NS	NS
Etches	7	W	NS	NS	NS	NS
Fairweather	7	A,M	NS	NS	NS	NS
Galena	6,7	M	NS	NS	NS	LS
Grant	3,4	M,D	S	LS	S	NS
Gulliford	2,3	S,W	LS	S	LS	NS
Hastings	5,6	M,A	LS	NS	LS	LS
Henning	5,4	M	S	LS	NS	NS
Howarth	6,7	M	NS	NS	NS	LS
Iltcoola	4	M,I	NS	LS	LS	LS
Kane	5–7	M,R	S	NS	LS	NS
Kullah	7	A,R	NS	NS	NS	NS
Lawless	2,1	S	S	S	NS	NS
Manning	3	S,W	LS	S	LS	NS
Mazama	4,3	M,D	S	LS	LS	NS
Midday	5,4	M,D	NS	NS	S	LS
Miner	7	A,R	NS	NS	NS	NS
Nicomen	2	S	S	S	NS	NS
Parawest	4,3	M,S	S	S	NS	NS
Pasayten	3,2	M	S	LS	NS	NS
Pefferle	3	S	S	S	LS	NS
Pitin	6,7	H,R	NS	LS	NS	NS
Princeton	7	A,M	NS	NS	NS	NS
Riddell	4	M	S	NS	LS	LS
Rock Outcrop	7	R	NS	NS	NS	NS
Selish	5–7	M,R	S	LS	LS	NS
Separation	7	A,M	NS	NS	NS	NS
Shinish	5,4	D,M	LS	NS	LS	LS
Skaist	5–7	R,H	LS	NS	NS	NS
Steeplands	6,7	A,R	NS	NS	NS	NS
Thalia	5,6	M	LS	NS	LS	LS
Thynne	7	W	NS	NS	NS	NS
Trehearne	5,6	M	LS	NS	LS	LS
Tulameen	4,5	M	S	NS	LS	LS
Whipsaw	5–7	M	NS	NS	LS	LS
Wilbert	2,3	S	S	S	LS	NS

1. **Forest capability classes**
   1. > 111 cu ft/ac per yr
   2. 91–110 cu ft/ac per yr
   3. 71–90 cu ft/ac per yr
   4. 51–70 cu ft/ac per yr
   5. 31–50 cu ft/ac per yr
   6. 11–30 cu ft/ac per yr
   7. < 10 cu ft/ac per yr
2. **Limiting factors**
   (a) **Soil moisture**
   M—soil moisture deficiency
   W—excessive soil moisture
   I—inundation
   (b) **Permeability**
   D—limited rooting depth and permeability
   R—restriction of rooting zone by bedrock
   (c) **Climate**
   H—growth limited by snow accumulations and/or short growing season
   A—droughty or arid conditions
   (d) **Miscellaneous**
   S—minor accumulations of adverse soil properties
3. **Species suitability**
   S—suitable
   LS—limited suitability
   NS—not suitable

Luvisol and Eutric Brunisol subgroups. Soils of the Riddell and Iltcoola series, which are developed on alluvial deposits, are subject to droughtiness or to inundation during part of the growing season.

Soils rated Class 4 occupy the largest combined area and make up about 38% of the Tulameen map sheet area. The productivity of these soils is 51 to 70 cubic feet per acre annually for lodgepole pine, Engelmann spruce, and Douglas-fir. The soils of this class are distributed throughout the area.

Class 5 soils, which have a productivity of 31 to 50 cubic feet per acre annually, are found on a variety of parent materials. The main limitations are soil moisture deficiency, restriction of the rooting zone by bedrock, and droughtiness. Soils of the Alleyne, Asp, Britton, Henning, Midday, Thalia, and Trehearne map units have one or more of these limitations. Shallowness to bedrock is a major limitation in the lithic soil series (Bankeir, Kane, and Selish), whereas the lithic Skaist series is further limited by a short growing season and cold soil temperatures. Lodgepole pine was used as the indicator species on lithic soils, whereas ponderosa pine has been rated on the coarse textured Asp series and the Dark Gray Chernozemic Darcy and Coalmont series. Class 5 soils make up about 33% of the area.

About 12% of the area is rated Class 6 and 7 for forest capability. Soils of the Brenda, Galena, and Howarth map units and the Steeplands land type produce less than 30 cubic feet per acre annually of wood, mainly ponderosa pine. On soils of the Bluey, Etches, and Coley map units tree growth is limited to less than 10 cubic feet per acre annually because of excessive wetness. The grassland soils of the Princeton and Fairweather map units are limited to the same tree growth rate because of droughtiness and soil moisture deficiency. Similar growth rates apply to Bonnevier soils in regions that have short growing seasons and deep snow. Most Steepland and Rock Outcrop map units are rated Class 7.

Major Factors Affecting Forest Growth

Soil drainage

The drainage condition of each soil series in the Tulameen area is influenced by the type of parent material, the topographic location, the position of the soil on a slope, aspect and exposure, shallowness to bedrock, and the proximity to water.

Particular emphasis has been placed on soil drainage because the moisture status of the soil is an important factor in determining forest productivity and species suitability in this generally arid region of the province. Forest growth is highest on moderately well to imperfectly drained soils for the largest range of species, that is, for Douglas-fir, lodgepole pine, and Engelmann spruce. The highest rating for the rapidly and well-drained soils at the lower elevations of the area is Class 5. These units support slow-growing ponderosa pine and occasional Douglas-fir.

The poorly drained soils in depressions usually support stands of Engelmann spruce as well as a variety of shrubs.

Permeability and stoniness

From observed field studies, the B horizon of the Gray Luvisol soils found in the area may restrict rooting depth and reduce the space available for stand root development. The proximity to bedrock results in a similar restriction to forest growth on many of the upland regions.

Forest growth is limited on some alluvial fans and talus slopes as a result of a combination of adverse factors. Stocking is low because much of the surface area is occupied by rock. On those soils of colluvial origin, slopes are steep and the moisture that is received is generally rapidly shed. Only a small amount of finer textured material is present. Also, these sites are generally exposed.

Species suitability

Throughout the area the best stands of lodgepole pine occur on moderately well drained to imperfectly drained soils.

In general, growth of Douglas-fir in the Tulameen area is not outstanding. Douglas-fir is not found at the higher elevations of the Trepanege Plateau and the Hozameen Range nor on the grasslands and in the poorly drained depressions. Douglas-fir is best suited to deep soils that are influenced by seepage. Stand measurements on these soils showed an MAI up to 100 cubic feet per acre annually for Douglas-fir.

Ponderosa pine is restricted to the drier soils at lower elevations, where there is apparently less competition from other tree species.

The moderately well to imperfectly drained soils developed on till slopes, in valley bottoms, and in depressions are the best sites for Engelmann spruce. Here, this species is vigorous and stands that have an MAI of over 80 cubic feet per acre are common.

SOILS AND WILDLIFE CAPABILITY

by

D. Blower, E. W. Taylor, and T. M. Lord

The main ungulate species found in the Tulameen area is mule deer. Deer populations are fairly well distributed throughout the lower plateau, but the greatest concentration of deer occurs south of the area in the Similkameen Valley and the surrounding uplands.

During the winter, deer concentrate mainly on the lower slopes and terraces of the valleys. Such regions generally include those parts of the Steeplands land type or the Alleyne map units that have southerly or westerly slope aspects. The Dark Gray Chernozemic, Brunisolic, and Regosolic soils of these units provide adequate browse under a fairly light snow cover.

In early spring, deer move onto southern slopes in the grasslands and dry ponderosa forest. In the area these units are the lowest parts of the Brenda, Britton, Connaly, Princeton, Tulameen, Howarth, and Midday map units. Early forage occurs on the coarse textured Dark Gray terrace soils of the valleys, which are represented by the Galena, Asp, Riddell, Trehearne, and Thalia map units.

During the summer, the animals move into the Douglas fir – pine grass forest on Gray Luvisol soils of the Connaly and Britton map units. By late summer, deer are widely dispersed throughout the lower plateau and in the subalpine regions of Bonnevier soils that lie west of the Tulameen River and on the Trepanege Plateau.

The moose population is low in the area, but winter concentrations of these animals occur near Pennask Lake on the Organic soils of the Etches map unit. The population is scattered throughout the middle plateau during the summer. The animals probably forage on plant communities associated with Bull, Gulliford, Grant, Pefferle, and Etches soils.

Black bears occur in the area. Populations of mountain goats, bighorn sheep, and elk are small and limited to units in the highland plateaus and valleys.

Waterfowl production is limited in the area and is concentrated mainly in small lakes and bogs associated with major valleys, grasslands, and open forest. Small lakes and potholes within the Princeton map unit provide good habitat for waterfowl production. Moderate waterfowl production occurs in potholes of the Otter Creek valley and in the region around Boss, Davis, and Shea lakes. Waterfowl are produced in small lakes and potholes distributed within the grasslands unit of Fairweather soils east of Quilchena Valley and within the Coley unit that surrounds Tommy Lake.

Generally, the lakes and marshes of the lower plateau have more mineral and organic nutrients than lakes at higher elevations. The high pH and fertility of these water bodies, combined with the suitability of the shorelines for nesting sites, are probably responsible for the higher waterfowl populations.

All species of grouse are found throughout the area.

SOILS AND RECREATION CAPABILITY

by

D. R. Benn and T. M. Lord

The rolling upland plateau, which is the characteristic land surface of the Tulameen area, is interrupted by steep mountainous terrain and many deeply incised valleys, streams, and lakes.

Plateau uplands, which are dominated by soils of the Wilbert, Mazama, Lawless, and Grant catenas, are inaccessible to ordinary vehicles. Some hunting of grouse and mule deer occurs in season. Where accessible, high-elevation lakes, such as Pennask, Paradise, and Reservoir, provide good angling for trout.

Most of the lower plateau areas of Gray Luvisol, Eutric Brunisol, and Chernozemic soils are readily accessible by

car or truck. An extensive network of logging and mining roads complemented by riding trails and jeep tracks leads through semiopen forest, parklands, and grasslands. During the summer and fall, the well-drained soils of the Princeton, Fairweather, Tulameen, Connaly, Britton, and Brenda map units provide good opportunities for extensive activities. Riding, hiking, hunting, and angling in the many small lakes around Aspen Grove are important attractions.

The soils that border the Tulameen and Coldwater rivers and their tributaries are well suited to such activities as camping, boating, and cottaging. These soils of the Thalia, Trehearne, Asp, and Riddell map units are coarse textured and rapidly drained. Vegetation consists mainly of shrubs, grasses, and light tree cover. The cold overnight temperatures in summer limit the recreation capability.

Because of its fairly large size and its shoreline of coarse textured Thalia and Riddell soils, Otter Lake is the only lake suited for intensive recreation activities, such as camping, bathing, cottaging, and boating. There is risk of water pollution and soil deterioration by the construction of services necessary to supply the large campsites and numerous summer homes. Such intensive use of highly permeable Thalia soils around Allison Lake shoreline is of concern at present.

The three small subalpine regions of Bonnevier soils in the area are accessible by road. These units, which are located near timberline on Thynne, Kathleen, and Pennask mountains, provide scenic views and opportunities for viewing wildlife and alpine vegetation.

"Rock hounding" and exploring relict mine sites are important recreation activities in the Princeton vicinity. Many interesting rock formations, fossil sites, and abandoned mines are readily accessible. Most of these activities are concentrated within the Steeplands and the Alleyne map units.

PART II

SOIL DEVELOPMENT AND CLASSIFICATION

SOIL FORMATION

Soil formation is a function of climate, vegetation, relief, and drainage acting on parent material over a period of time. Although all these factors influence soil development, the influence of each differs from place to place. In the Tulameen area, Gray Luvisol (Gray Wooded), Podzolic, and some Chernozemic soils have developed on similar parent materials of comparable age. Climatic factors, such as moisture distribution, temperature, solar energy, and vegetation probably have the most influence on soils of the area.

SOIL MAPPING AND CLASSIFICATION

Soil mapping identifies and classifies soils, describes and separates the different kinds of soil units, and delineates the boundaries of these units on the map. The present soil survey is basically reconnaissance in nature, but it incorporates soils information from two detailed-reconnaissance soil surveys (Green 1963; Spilsbury 1963).

The soil series are the basic units for mapping and classifying the soils of the Tulameen area. Soil series are classified according to the taxonomic system developed in Canada (Canada Department of Agriculture Publ. 1455 1970). Under this system soils are grouped into six categories: order, great group, subgroup, family, series, and type. At the order, great group, and subgroup levels, differences in the morphological features of the soil profile, which are influenced by soil genesis, are the main criteria for division. The bases for dividing subgroups into families, series, and types are the differences in composition of parent materials, kind of development and thickness of soil horizons, and drainage.

KEY TO THE SOILS

In Table 5, the soils are grouped according to characteristics of the parent materials and arranged according to the classification outline. The chief kinds of profiles were classified into great groups and subgroups. The main features of the great groups and subgroups are given below.

Chernozemic Order

Dark Brown Great Group

Dark Brown soils have Chernozemic Ah or Ap horizons darker than 3.5 moist and 4.5 dry with chromas usually greater than 1.5 dry. They are usually associated with and

Table 5. Classification of soils of the Tulameen area

Soils on morainal deposits	
On moderately coarse and medium textured, grayish brown till	
Miner series	Lithic Rego Dark Brown
Princeton series	Orthic Black
Separation series	Eluviated Black (Cumulic)
Collett series	Carbonated Rego Dark Gray
Connaly series	Orthic Gray Luvisol
Bull series	Gleyed Orthic Gray Luvisol
Kane series	Lithic Orthic Gray Luvisol
Grant series	Brunisolic Gray Luvisol
Mazama series	Degraded Eutric Brunisol
Pefferle series	Gleyed Degraded Eutric Brunisol
Bankeir series	Lithic Orthic Eutric Brunisol
Gulliford series	Rego Humic Gleysol
On medium and moderately fine textured, grayish brown till	
Kullah series	Lithic Orthic Dark Brown
Kullah series	Lithic Orthic Dark Brown
Fairweather series	Eluviated Black
Brenda series	Orthic Dark Gray
On moderately fine textured, reddish brown till	
Coalmont series	Orthic Dark Gray
Britton series	Orthic Gray Luvisol
Selish series	Lithic Orthic Gray Luvisol
Soils on undivided till and colluvium	
On very coarse and moderately coarse textured materials	
Darcy series	Orthic Dark Gray
Tulameen series	Orthic Gray Luvisol
Coquihalla series	Mini Ferro-Humic Podzol
Nicomen series	Orthic Humo-Ferric Podzol
Lawless series	Mini Humo-Ferric Podzol
Pitin series	Sombric Humo-Ferric Podzol
Skaist series	Lithic Mini Humo-Ferric Podzol
Alleyne series	Degraded Eutric Brunisol
Pefferle series	Gleyed Degraded Eutric Brunisol
Bankeir series	Lithic Orthic Eutric Brunisol
Wilbert series	Degraded Dystric Brunisol
Bonnevier series	Alpine Dystric Brunisol
Chuwanten series	Gleyed Alpine Dystric Brunisol
Gulliford series	Rego Humic Gleysol
Soils on lacustrine deposits	
On medium and fine textured lake deposits	
Howarth series	Orthic Dark Gray
Corbett series	Rego Dark Gray
Midday series	Orthic Gray Luvisol
Eastmere series	Brunisolic Gray Luvisol
Boot series	Cumulic Regosol
Soils on fluvial and glaciofluvial deposits	
On coarse and medium textured stream and outwash deposits	
Allison series	Orthic Black
Galena series	Orthic Dark Gray
Hastings series	Orthic Dark Gray
Shinish series	Orthic Gray Luvisol
Pasayten series	Mini Humo-Ferric Podzol
Whipsaw series	Orthic Eutric Brunisol
Asp series	Degraded Eutric Brunisol

Trehearne series	Degraded Eutric Brunisol
Henning series	Orthic Dystric Brunisol
Parawest series	Cumulic Regosol
Soils on alluvial deposits	
On recent stream deposits	
Riddell series	Rego Dark Gray
Iltcoola series	Gleyed Orthic Regosol
Thynne series	Rego Humic Gleysol
Manning series	Humic Eluviated Gleysol
Bluey series	Low Humic Eluviated Gleysol
On fan deposits	
Bromley series	Orthic Gray Luvisol
Thalia series	Degraded Eutric Brunisol
Soils on organic materials	
Coley	Typic Mesisol
Etches	Typic Mesisol
Land types	
Rock Outcrop	
Steeplands	

developed from the decomposition of a cyclic growth of mesophytic grasses and forbs.

Orthic Dark Brown soils have Ah or Ap horizons underlain by a Bm or a weak to moderately textural Btj or Bt. The B horizons are free of primary carbonate. Soils of the Kullah series are Lithic Dark Brown with consolidated bedrock 4 to 20 inches below the surface of the mineral soil.

Rego Dark Brown soils have Ah or Ap horizons underlain by C horizons. Soils of the Miner series are Lithic Rego Dark Brown with consolidated bedrock at 4 to 20 inches below the surface of the mineral soil.

Black Great Group

Black soils have Chernozemic Ah or Ap horizons with values darker than 3.5 moist or dry and chromas of 1.5 or less moist. Black soils are usually, but not exclusively, associated with and developed from the decomposition of a cyclic growth of mesophytic grasses and forbs. However, they may also be associated with thin or discontinuous tree and shrub cover.

Orthic Black soils have Ah or Ap horizons underlain by a colored Bm or a weak to moderately textural Btj or Bt. The B horizon is free of primary carbonates. The Princeton and Allison series are Orthic Black soils.

Eluviated Black soils have Ah or Ap horizons underlain by a sequence of eluvial Ahe, Ae, and transitional AB horizons overlying weakly to moderately developed illuvial B horizons. Soils of the Fairweather series are Eluviated Black; Separation soils are Cumulic Eluviated Black.

Dark Gray Great Group

Dark Gray soils have Chernozemic A horizons modified by degradation or by the effects of the accumulation and decomposition of forest vegetation, including leaf mats. These soils support a mixed vegetation of trees, shrubs, forbs, and grasses that is transitional between grassland and forest.

Orthic Dark Gray soils have L–H, Ah–Ahe, L–H, Ahe, or Ap horizons underlain by a colored Bm or textural Bt horizon free of primary carbonates. The Brenda, Coalmont, Darcy, Howarth, Hastings, and Galena series are Orthic Dark Gray soils.

Rego Dark Gray soils have L–H, Ah–Ahe, L–H, Ahe, or Ap horizons underlain by C horizons that are usually strongly to moderately calcareous. The Corbett and Riddell series are Rego Dark Gray soils. Collett soils are Carbonated Rego Dark Gray soils that have A and B horizons of secondary carbonate enrichment.

Luvisolic Order

Gray Luvisol (Gray Wooded) Great Group

Gray Luvisol soils have (L–H) horizons, eluvial Ae horizons, and textural B horizons in which silicate clay is the main accumulation product. They are well and imperfectly drained soils that have developed under deciduous, mixed deciduous–coniferous, or boreal forests, or under forest–grassland transition zones.

Orthic Gray Luvisol soils have L–H, light-colored Ae, and Bt horizons. An Ah horizon, if present, is less than 2 inches thick. Connaly, Britton, Tulameen, Midday, Bromley, and Shinish soils are Orthic Gray Luvisols. The soils of the Kane and Selish series are Lithic Gray Luvisols with consolidated bedrock 4 to 20 inches below the surface of the mineral soil. Bull soils are Gleyed Orthic Gray Luvisols.

Brunisolic Gray Luvisol soils have L–H or Ah horizons over Ae and Bt horizons. The upper Ae1 is brown with chromas of 3.0 or more and usually grades to a light-colored lower Ae2. The Grant and Eastmere series are Brunisolic Gray Luvisol soils.

Podzolic Order

Ferro-Humic Podzol Great Group

Ferro-Humic Podzols have podzolic B horizons in which organic matter, Fe, and Al are the main accumulation products. They have mineral–organic surface horizons L–H or Ah, usually underlain by eluviated light-colored Ae horizons. The upper 4 inches of the B horizon contains more than 10% organic matter.

Mini Ferro-Humic Podzols have the general characteristics of the great group, but they have less than 1 inch of Ae, or lack a visible Ae. Soils of the Coquihalla series are Mini Ferro-Humic Podzols.

Humo-Ferric Podzol Great Group

Humo-Ferric Podzols have podzolic B horizons in which organic matter, Fe, and Al are the main accumulation products. The upper 4 inches of the B horizon contain less than 10% organic matter.

Orthic Humo-Ferric Podzols have the general characteristics of the great group and L–H, Ae, and Bfh or Bf horizons. The Ae horizon is more than 1 inch thick. Nicomen soils are Orthic Humo-Ferric Podzols.

Mini Humo-Ferric Podzols have the general characteristics of the great group, except that the Ae horizon is generally less than 1 inch thick, discontinuous, indistinct, or missing. Soils of the Lawless and Pasayten series are Mini Humo-Ferric Podzols; Skaist soils are Lithic Mini Humo-Ferric Podzols with consolidated bedrock 4 to 20 inches below the surface of the mineral soil.

Sombric Humo-Ferric Podzols have the general characteristics of the great group, except that the dark-colored, mineral organic horizons (Ah) are 3 inches or more thick. The Pitin soil series is tentatively classified in this subgroup.

Brunisolic Order

Eutric Brunisol Great Group

These are Brunisolic soils that, under virgin conditions, have organic surface horizons (L–H)) over Bm horizons in which the base saturation is 100%, and the pH ($CaCl_2$) is usually 5.5 or higher.

Orthic Eutric Brunisols have organic surface horizons (L–H) overlying Bm horizons that usually have a chroma of 3 or more. Whipsaw soils are Orthic Eutric Brunisols. Soils of the Bankeir series are Lithic Eutric Brunisols with consolidated bedrock 4 to 20 inches below the surface of the mineral soil.

Degraded Eutric Brunisols have either an Aej or Ae horizon and a Bm horizon. The B horizon may contain illuvial clay (Btj) or some sesquioxides. Mazama, Alleyne, Asp, Trehearne, and Thalia soils are Degraded Eutric Brunisols. Pefferle soils are Gleyed Degraded Eutric Brunisols with mottling and dull matrix colors in the B horizon.

Dystric Brunisol Great Group

These are Brunisolic soils that, under virgin conditions, have organic surface horizons (L–H) over Bm horizons in which the base saturation is usually 65% to 100% and the pH ($CaCl_2$) usually 5.5 or lower.

Orthic Dystric Brunisols have organic surface horizons (L–H) over Bm horizons. The Bm horizons usually have chromas of 3 or more. The soils of the Henning series belong to this subgroup.

Degraded Dystric Brunisols have either an Aej or Ae horizon and a Bm horizon that contains insufficient illuvial material to meet the requirements of the podzolic B. The soils of the Wilbert series belong to this subgroup.

Alpine Dystric Brunisols have thin organic surface layers (L–H) and moderately thick, turfy Ah horizons over Bm horizons. Bonnevier soils belong to this subgroup. Chuwanten soils are Gleyed Alpine Dystric Brunisols with dull colors in the B horizons.

Regosolic Order

Regosol Great Group

These are well and imperfectly drained mineral soils with good to moderate oxidizing conditions. The horizons of these soils are too weakly developed to meet the requirements of soils in any other order.

Orthic Regosols have from the surface, or below any nonchernozemic Ah horizon, color values that are uniform with depth, or color values that increase gradually with the depth of the control section (40 inches). Soils of the Iltcoola series are Gleyed Orthic Regosols with mottling and dull colors within 20 inches of the surface.

Cumulic Regosols have from the surface, or below any nonchernozemic Ah horizon, color values that vary with the depth in the control section (40 inches) by one or more units. Boot and Parawest soils are Cumulic Regosols.

Gleysolic Order

Humic Gleysol Great Group

These Gleysolic soils have an Ah horizon more than 3 inches thick or an Ap with more than 3% organic matter.

Rego Humic Gleysols have a noneffervescent Ah horizon and lack a B horizon. The soils of the Gulliford and Thynne series belong to this subgroup.

Eluviated Gleysol Great Group

These are Gleysolic soils with Aeg and Btg horizons.

Humic Eluviated Gleysols have Ah horizons more than 3 inches thick and have Aeg and Btg horizons. Manning soils belong to this subgroup.

Low Humic Eluviated Gleysols have no Ah horizons or an Ah horizon up to 3 inches thick. They have Aeg and Btg horizons. Bluey soils belong to this subgroup.

Organic Order

Mesisol Great Group

These are soils developed mainly from organic deposits and contain 30% or more of organic matter. They have a dominantly mesic middle tier, or middle and surface tiers if a terric, lithic, hydric, or cryic contact occurs in the middle tier.

Typic Mesisols consist of dominantly mesic organic material throughout the middle and bottom tiers. Coley soils belong to this subgroup.

Terric Mesisols have a terric layer beneath the surface tier but within the control section. Soils of the Etches series are Terric Mesisols.

DESCRIPTIONS AND ANALYSES OF SOIL SERIES

This section of the report lists, in alphabetical order, the profile descriptions of all the named soil series in the area. Physical and chemical analyses are given for most of the important soils. The methods of soil analysis are given on page 159 of the report.

ALLEYNE SERIES

The Alleyne soils are Degraded Eutric Brunisols of the Alleyne catena. They have organic L–H layers, grayish sandy loam Ae horizons, and very pale brown Bm horizons that grade with depth into slightly acid sandy loam or gravelly loamy sand colluvium, or till.

Type location: Map sheet 92 H/SE, 49°23.8′ N 120°08.7′ W.

Range in characteristics: The solum is 20 to 50 inches thick. Gravel content generally increases with depth. Bedrock occurs 30 to 60 inches under the surface. The A horizons are grayish brown sandy loam 12 to 20 inches thick. The brown B horizons are 10 to 30 inches thick, and may contain weak clay flows or clay bridges.

Similar series: Tulameen soils have argillic horizons; Trehearne soils have thick sand or loamy sand sola; and Thalia soils have dark grayish brown A horizons and gravelly loamy sand C horizons. Asp soils are 12 to 18 inches thick over cobbly gravel. Mazama soils have dark brown Bm horizons.

Landform and climate: Alleyne soils most commonly occur on steep to very steep side slopes of deeply entrenched valleys. Parent materials are moderately coarse textured, slightly acid to neutral colluvium and ablation till. Elevations range from 3000 to 4500 feet. The semiarid climate has a mean annual precipitation of 13 to 21 inches and mean annual temperatures of 38° to 42° F. The frost-free period ranges from less than 50 to about 90 days, and the growing season ranges from 1650 to 2150 degree-days above 42° F.

Associated soils: Alleyne soils occur mainly with Tulameen, Asp, Thalia, and Connaly soils.

Drainage and permeability: Well drained with slow runoff and moderate permeability.

Vegetation: Douglas-fir – pine grass habitat type, characterized by semiopen to moderately dense stands of Douglas-fir, lodgepole pine, and ponderosa pine over a ground cover of bearberry, buffaloberry, pine grass, arnica, and twinflower.

Present use: Important winter range for deer; supplemental summer range for cattle; limited timber production.

Distribution and extent: Valleys of the Similkameen and Tulameen rivers and their tributaries. Alleyne soils predominate on about 41,500 acres.

Remarks: Alleyne soils were formerly classified as Degraded Brown Wooded and Gray Forested. The series was established in the Princeton map area in 1960.

Morphological description: Alleyne series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–H	0.5–0	grass, conifer needles, and woody litter								
Ae1	0–8	light gray 10YR 7/2	light brownish gray 10YR 6/2	sandy loam	moderate	medium	granular	friable	<10	neutral
Ae2	8–15	light brownish gray 10YR 6/2	grayish brown 10YR 5/2	loamy sand	moderate	medium	subangular blocky	friable	<10	slightly acid
Bm	15–25	very pale brown 10YR 7/3	pale brown 10YR 6/3	sandy loam	moderate	medium	subangular blocky	firm	<10	medium acid
BC	25–31	very pale brown 10YR 7/3	brown 10YR 5/3	loamy sand	weak	fine	subangular blocky	firm	10–20	medium acid
C1	31+	light brownish gray 10YR 6/2	grayish brown 10YR 5/2	sandy loam	moderate	medium	angular blocky	firm	10–20	slightly acid

Analyses: Alleyne series

Horizon	Depth inches	pH in H_2O	Organic matter %	Particle size distribution, %		
				Sand	Silt	Clay
Ae1	0–8	6.6	1.8	75.5	11.5	13.0
Ae2	8–15	6.1	0.9	80.5	9.5	10.0
Bm	15–25	5.8	0.4	77.7	8.7	13.6
BC	25–31	6.0		79.7	9.7	10.6
C1	31+	6.3	0.2	74.6	14.4	11.0

ALLISON SERIES

The Allison soils are Orthic Black soils of the Galena catena. They have thick black Ah horizons and grayish brown gravelly loamy sand Bm horizons over weakly stratified sand and cobbly gravel.

Profile location: 49°32.0′ N 120°26.9′ W.

Range in characteristics: The solum is 24 to 30 inches thick. Gravel content increases from 10% to 20% in the Ae horizon and to more than 50% in the C horizon. The Ah horizons are 8 to 10 inches thick, and are black to very dark gray loamy sand. The BC horizons average 24 inches in thickness, and are dark grayish brown gravelly loamy sand. A Ck horizon occurs at a depth of about 30 inches.

Similar series: Princeton and Fairweather soils are finer textured and occur on till materials. Galena and Hastings soils have degraded surface horizons.

Landform and climate: Allison soils occur on outwash terraces and deltas that are often kettled and hummocky. Elevations range from 2300 to 3500 feet. Parent materials are very coarse textured, neutral to slightly alkaline deposits. The climate is semiarid. The mean annual rainfall is 13 to 21 inches. The mean annual temperature is 38° to 42° F. The frost-free period is 75 to 90 days or more, and there are 1900 to more than 2150 growing degree-days over 42° F.

Associated soils: Galena soils are associated with Allison soils in the Galena catena. Allison soils occur with Whipsaw soils, members of the Princeton catena, and in the Trehearne map unit.

Drainage and permeability: Rapidly drained and very permeable.

Vegetation: Fescue–eriogonum habitat type: grasslands of bluebunch wheat grass, Idaho fescue, tall white eriogonum, and silky lupine.

Present use: Grazing by livestock and deer.

Distribution and extent: Small valleys near Aspen Grove and Jura. Allison soils occur with Galena soils on about 2800 acres.

Remarks: The Allison series was established in the Tulameen map area in 1960.

Morphological description: Allison series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
Ah	0–6	black to very dark gray 10YR 2.5/1	black 10YR 2/1	loamy sand	moderate	fine	granular	friable	< 10	slightly acid
Bm	6–15	dark grayish brown to dark brown 10YR 4/2.5	very dark grayish brown 10YR 3/2	gravelly loamy sand	weak	fine	subangular blocky	loose, friable	> 20	neutral
BC	15–30	dark grayish brown 10YR 4/2 to brown 10YR 5/3	very dark grayish brown 10YR 3/2	gravelly loamy sand			single grain	loose	> 50	mildly alkaline
Ck	30+	brown 10YR 5/3		sand			single grain	loose	> 50	moderately alkaline

ASP SERIES

The Asp soils are Degraded Eutric Brunisols of the Asp catena. The soils have thin organic L–F–H and Ah horizons, brown sandy loam Aej and Bm horizons, and gravelly C horizons.

Type location: Map sheet 92H/SE, 49°26.2′ N 120°33.5′ W.

Range in characteristics: The solum is 10 to 15 inches thick. Gravel content increases from 15% to over 50% in the lower profile. Ae horizons are 3 to 6 inches thick, and are light brownish gray to brown sandy loam. The brown B horizons are 5 to 11 inches thick and are slightly acid to neutral. These horizons overlie gravelly sand or cobbly loamy sand C horizons.

Similar series: Whipsaw soils have distinct Ah horizons. Other Degraded Eutric Brunisols have much thicker sola that have developed from till or deep glaciofluvial deposits.

Landform and climate: Asp soils occur on outwash terraces and deltas that are often kettled and hummocky. Elevations range from 2700 to 3500 feet. Parent materials are very coarse textured, neutral to slightly alkaline deposits. The semiarid climate has hot, dry summers and long cold winters. The mean annual rainfall is 13 to 21 inches and mean annual temperatures are 38° to 42° F. The frost-free period is 75 to 90 days or more, and growing degree-days range from 1650 to more than 2150 days above 42° F.

Associated soils: The main soils associated with Asp soils in the catena are Whipsaw Orthic Dark Gray soils. Asp soils occur with Tulameen, Alleyne, Thalia, and Connaly soils.

Drainage and permeability: Rapidly drained with rapid to moderately rapid permeability.

Vegetation: Douglas-fir – pine grass habitat type, characterized by a moderately dense forest of Douglas-fir and ponderosa pine with pine grass, bearberry, and forbs in the understory.

Present use: Grazing by livestock and deer on native range; limited production of forage crops under irrigation.

Distribution and extent: Outwash terraces in main valleys. Asp soils predominate on about 6200 acres.

Remarks: The Asp soil series was established in the Princeton map area in 1960.

Morphological description: Asp series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L	1–0.5	layer of pine needles								
F–H	0.5–0	semidecomposed needles and grass								
Ah	0–1	dark grayish brown 10YR 4/2 to gray 10YR 5/1	black 10YR 2/1	sandy loam	weak	fine	granular	soft, friable	<15	medium acid
Ae	1–4	brown 10YR 5/3	dark brown 10YR 3/3	sandy loam	weak	medium	subangular blocky and granular	soft, friable	<15	medium acid
Bm	4–8	brown 10YR 5/3	dark yellowish brown 10YR 3/4	loamy sand	moderate	medium to fine	subangular blocky and granular	slightly hard, firm	>20	slightly acid
IIBC	8–15	brown 10YR 5/3	dark grayish brown 10YR 4/2 to dark brown 10YR 4/3	gravelly sand			single grain	loose	>75	neutral
IIC	15+	brown 10YR 5/3 and variegated colors		sand and gravel			single grain	loose	>75	neutral

Analyses: Asp series

Horizon	Depth inches	pH in H_2O	Particle size distribution %		
			Sand	Silt	Clay
Ah	0–1	6.1	66.8	27.8	5.4
Ae	1–4	6.0	69.4	26.7	3.9
Bm	4–8	6.4	73.0	22.3	4.7
IIBC	8–15	6.6	91.5	7.3	1.2
IIC	15+	6.9	96.6	3.0	0.4

BANKEIR SERIES

The Bankeir soils are Lithic Eutric Brunisols of the Mazama catena. They have thin L and F–H layers and pale brown loam or sandy loam B horizons that lie directly on consolidated bedrock.

Type location: 49°56.6′ N 120°19.2′ W.

Range in characteristics: The solum averages 15 inches, and has a range in thickness of 4 to 20 inches. The coarse skeleton comprises 5% to 20% of the solum. Roots are concentrated in the upper 6 to 10 inches of the profile. The soils have brown or pale brown, medium acid, sandy loam or loam B horizons. The C horizon is neutral or slightly acid till or colluvium.

Similar series: Skaist soils are Lithic Mini Humo-Ferric Podzols that have an Ae horizon and a strong reddish chroma; Kane and Selish soils are Lithic Gray Luvisols that have distinct argillic horizons.

Landform and climate: Bankeir soils occur on moderately to steeply sloping abraded ridges on the plateau uplands. The elevation ranges from 4000 to 5500 feet. Parent materials are moderately coarse textured, neutral till. Argillite, basalt, and granodiorite rocks underlie the soil mantle and predominate in the parent material. The climate is modified continental, characterized by warm, dry summers and cold winters and an annual precipitation of 15 to more than 21 inches. The mean annual temperature is about 38° to 40° F. The frost-free period is less than 50 days and there are 1200 to 1650 growing degree-days above 42° F.

Associated soils: Bankeir soils are associated with Mazama and Pefferle soils in the catena and occur with Wilbert and Connaly soils.

Drainage and permeability: Well drained with moderately rapid runoff and moderate permeability.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a moderately dense forest of lodgepole pine, Douglas-fir, and Engelmann spruce with pine grass, red alpine blueberry, and arnica in the understory.

Present use: Wintering areas for deer; limited summer grazing for deer and livestock; very limited forestry.

Distribution and extent: Plateau regions throughout the area. Bankeir soils occur on 121,600 acres of the Mazama catena.

Remarks: The Bankeir series was established in the Tulameen map area in 1962.

Morphological description: Bankeir series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L	0.75–0.5	fresh grass, leaves, and twigs								
F–H	0.5–0	partially decomposed litter with some bleached mineral grains								
Bm1	0–4	pale brown 10YR 6/3	dark yellowish brown 10YR 3/4 and 4/4	loam	moderate and weak	fine	granular and subangular blocky	friable, slightly plastic	< 5	medium acid
Bm2	4–11	pale brown 10YR 6/3	dark brown 10YR 4/3	loam	moderate	medium and coarse	subangular blocky	firm, plastic, slightly sticky	<10	medium acid
BC	11–22	brown 10YR 5/3	dark brown 10YR 4/3 and dark yellowish brown 10YR 3/4	sandy loam	strong	medium and coarse	subangular blocky	very firm, plastic, slightly sticky	<10	slightly acid
R	22+	volcanic rock								

Analyses: Bankeir series

Horizon	Depth inches	pH in H_2O	Fe	Al	Particle size distribution %		
					Sand	Silt	Clay
Bm1	0–4	5.7	0.3	0.2	46.6	43.3	10.1
Bm2	4–11	6.0	0.4	0.2	50.9	38.4	10.7
BC	11–22	6.2	0.7	0.3	55.2	34.9	9.9

BLUEY SERIES

The Bluey soils are Low Humic Eluviated Gleysols of the Bluey catena. They have dark brown loam Ap horizons over a mottled sandy clay loam Btg horizon.

Type location: 49°42.4′ N 120°45.8′ W.

Range in characteristics: The solum is 8 to 12 inches thick. Gravel is generally absent. A horizons are very dark brown loam about 6 inches thick. Btg horizons 5 or 6 inches thick are dark brown, strongly mottled, sandy clay loam. A Ckg horizon occurs at 18 to 24 inches.

Similar series: Thynne, Manning, and Gulliford soils are Gleysolic soils. Thynne lacks a B horizon. Manning has a thick Ah horizon, and Gulliford is developed on moderately coarse and medium textured slightly acid materials.

Landform and climate: Bluey soils occur on level to gently sloping alluvial terraces at elevations of 2600 to 2900 feet. Parent materials are moderately fine textured, neutral alluvium. The climate is semiarid with hot, dry summers and long, cold winters. The mean annual rainfall is 13 to 21 inches, and mean annual temperatures are 38° to 42° F. Frost-free periods are greater than 90 days and the growing season exceeds 2150 days above 42° F.

Associated soils: Thynne soils are associated with Bluey soils. Bluey soils also occur with Manning, Riddell, and Iltcoola soils.

Drainage and permeability: Poorly drained and very slowly permeable.

Vegetation: Wetland plant communities that include sedges, willows, and grasses.

Present use: Pasture and hay.

Distribution and extent: Mainly confined to the Otter River valley. Bluey soils predominate on about 1600 acres.

Remarks: The Bluey soil series was established in the Tulameen map area in 1960.

Morphological description: Bluey series

Horizon	Depth inches	Color Moist	Texture	Structure			Consistence	Coarse fragments %	Reaction class
				Grade	Size	Form			
Ap	0–6	very dark brown 10YR 2/2	loam	weak	fine	subangular blocky	friable	nil	mildly alkaline
Btg	6–11	dark brown 10YR 3/3	sandy clay loam	moderate	medium	subangular blocky	sticky	nil	neutral
Cg	11–18	dark grayish brown 10YR 4/2	sandy clay loam			massive	sticky	nil	mildly alkaline
Ckg	18+	grayish brown 10YR 5/2	sandy clay loam			massive	sticky	nil	moderately alkaline

BONNEVIER SERIES

The Bonnevier soils are Alpine Dystric Brunisols of the Bonnevier catena. These soils have brown turfy Ah horizons overlying yellowish brown Bm horizons. Lower BC horizons are compact and stony.

Type location: Map sheet 92H/SE, 49°04.8′ N 120°45.9′ W.

Range in characteristics: The solum averages about 2 feet in thickness. Gravel increases with depth. Bedrock occurs within 2 to 3 feet of the surface. Reactions are strongly acid throughout the profile. Many fine roots occur in the A horizons and generally form a dense compact turf in the surface 2 to 3 inches. Ah horizons are dark brown to dark yellowish brown sandy loam about 12 inches thick. Bm horizons are 10 to 12 inches thick and are yellowish brown to brown sandy loam. They grade into pale brown C horizons.

Similar series: Pitin series has a similar profile, but it has BF horizons rather than the Bm horizons of the Bonnevier soils. Lawless and Nicomen soils lack the distinct, thick, Ah horizons of Bonnevier.

Landform and climate: Bonnevier soils occur on mountain ridges and slopes of low and moderate relief. Aspects are mainly south and west. Elevations range from 5800 to 6500 feet. Parent materials are coarse textured, strongly acid till, colluvial, and aeolian deposits. The cold continental climate has a mean annual precipitation of about 30 inches and mean annual temperatures of about 28° F. The frost-free period is variable but is usually less than 30 days. Growing degree-days range from 1200 to less than 800 days above 42° F.

Associated soils: Bonnevier soils are associated with the catenary members Pitin and Chuwanten, and with Lawless and Nicomen soils.

Drainage and permeability: Well drained and moderately permeable.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized mainly by an open cover of false-heather, moss-heather, blueberry, mountain valerian, and forbs.

Present use: Mainly grazing by big game.

Distribution and extent: The highest parts of the Cascade Mountains and the Trepanege Plateau. Bonnevier soils predominate on about 1800 acres.

Remarks: The Bonnevier soil series was established in the Princeton map area in 1960.

Morphological description: Bonnevier series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	0.25–0	decomposed leaves and grasses								
Ah1	0–5	brown 10YR 5/3 and 4/3	dark brown 10YR 3/3	fine sandy loam	strong	fine	granular	friable	< 5	strongly acid
Ah2	5–9	brown 10YR 5/3	dark brown 10YR 4/3	fine sandy loam	strong, weak	medium, fine	granular subangular blocky	friable	< 5	strongly acid
Bm	9–18	brown 10YR 5/3	dark yellowish brown 10YR 4/4	fine sandy loam	moderate	coarse	subangular blocky	friable	< 5	strongly acid
BC	18–24	pale brown 10YR 6/3	yellowish brown to dark yellowish brown 10YR 5/6 to 4/4	gravelly sandy loam	moderate	medium	subangular blocky	friable	> 75	strongly acid
C1	24–30	pale brown 10YR 6/3	light olive brown 2.5Y 5/4	gravelly sandy loam	strong	medium	angular blocky	firm, hard	> 40	strongly acid
R	30+	angular granitic rock								

BOOT SERIES

The Boot soils are Cumulic Regosols of the Eastmere catena. They have thick silt loam Ahb horizons that contain additions of upslope soil materials. The C horizons are pale yellow, medium acid, silt loams.

Type location: 49°56.2′ N 129°19.2′ W.

Range in characteristics: The solum is about 2 feet thick. Gravel is absent. Bedrock does not occur within 5 feet of the surface. A horizons are brown to light brownish gray silt loams that grade into pale yellow silt and silt loam.

Similar series: Parawest series, a Cumulic Regosol, is developed on coarse textured, strongly acid outwash materials; Cumulic Regosols of the Iltcoola complex are developed on coarse textured, neutral, alluvium.

Landform and climate: Boot soils occupy toe-slope positions on moderately to strongly rolling lake basins at elevations near 5000 feet. Parent materials are medium textured, medium acid deposits of silts and fine sands. The climate is continental modified by maritime influence. The mean annual precipitation is 20 inches or more, and mean annual temperatures are 38° F or less. The frost-free period is less than 50 days and the growing season is 1200 to 1650 days above 42° F.

Associated soils: The Boot series is associated with Eastmere soils.

Drainage and permeability: Well drained and moderately to slowly permeable.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense forest of Engelmann spruce, lodgepole pine, and subalpine fir, with an understory of blueberry, bunchberry, false-box, pine grass, and mosses.

Present use: Limited grazing by big game.

Distribution and extent: Lacustrine basin near Paradise Lake. Boot soils occur with Eastmere soils on 568 acres.

Remarks: The Boot soil series was established in the Tulameen map area in 1962.

Morphological description: Boot series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–H	1–0	forest litter								
Ah	0–18	light brownish gray 10YR 6/2	dark yellowish brown 10YR 3/4	silt loam	moderate	coarse	granular	slightly hard, friable	nil	medium acid
Ahb	18–23	brown 10YR 5/3	dark brown 7.5YR 3/2	silt loam	strong	fine and medium	subangular blocky	hard, firm	nil	medium acid
C1	23–36	pale yellow 2.5Y 7/4	light olive brown 2.5Y 5/4	silt loam	moderate	coarse	subangular blocky	firm	nil	slightly acid
C2	36+	pale yellow 2.5Y 7/4	light olive brown 2.5Y 5/4	silt loam	moderate	medium	platy and subangular blocky	firm	nil	medium acid

BRENDA SERIES

The Brenda soils are Orthic Dark Gray soils of the Brenda catena. They have thick, dark gray loam A horizons and brown to grayish brown B horizons. The C horizon is mildly alkaline loam till.

Type location: 49°48.4′ N 120°37.3′ W

Range in characteristics: The solum ranges between 20 and 35 inches in thickness. Coarse fragments occupy 5% to 20% of the soil volume. Fine and medium roots are common throughout the A and B horizons. The A horizons are dark gray to dark grayish brown loam or fine sandy loam. The pale brown to brown loam or clay loam B horizons frequently contain clay accumulations in root channels and pores. At depths of 25 to 33 inches below the surface, a horizon of lime carbonate occurs.

Similar series: Coalmont and Darcy series also belong to the Orthic Dark Gray subgroup, but the Coalmont soil is developed on dark brown to dark reddish brown clay loam till. Darcy series has a moderately coarse textured, slightly acid to neutral, sandy loam or loam parent material.

Landform and climate: Brenda soils occupy north and northeast aspects of elongated ridges and drumlins. The convex side slopes are moderately to strongly sloping. Parent materials are medium and moderately fine textured, neutral to mildly alkaline till. Underlying rocks are granodiorites, argillites, schists, and lavas. Elevations range from 3500 to 4000 feet. The climate is semiarid, characterized by a mean annual precipitation of 18 to 21 inches and mean annual temperatures of 38° to 40° F. Summers are warm and dry, and winters are cold. The frost-free period is 60 to 75 days and there are 1650 to 1900 growing degree-days above 42° F.

Associated soils: Brenda soils occur with Orthic Black Princeton soils and with Collett, Carbonated Rego Dark Gray soils.

Drainage and permeability: Well drained with slow runoff; moderately to slowly permeable.

Vegetation: Douglas-fir – Idaho fescue habitat type, characterized by a semi-open forest of ponderosa pine, Douglas-fir, and trembling aspen and a ground cover of Idaho fescue, bluebunch wheat grass, forbs, and shrubs.

Present use: Summer range for stock and deer; wintering areas for deer.

Distribution and extent: Drumlinized till plains near Aspen Grove. Brenda is the main soil on 8800 acres.

Remarks: The Brenda soil series was established in the Tulameen map area in 1960.

Morphological description: Brenda series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F–H	2–0	decomposed and semidecomposed organic litter								
Ah1	0–4	very dark grayish brown 10YR 3/2	very dark brown 10YR 2/2	loam	weak to strong	medium	prismatic to subangular blocky	slightly hard, firm	<10	slightly acid
Ahe1	4–6	dark gray 10YR 4/1	very dark brown 10YR 2.5/2	loam	moderate	medium to coarse	subangular blocky	slightly hard, friable	<10	slightly acid
Ahe2	6–15	dark grayish brown 10YR 4/2	very dark brown 10YR 2/2	loam	moderate	medium	subangular blocky	slightly hard, firm	<10	neutral
Bm	15–23	grayish brown 10YR 5/2.5	dark yellowish brown 10YR 3/4	loam	strong	fine	subangular blocky	hard, friable	<10	neutral
BC	23–27	light brownish gray 10YR 6/2	dark grayish brown 10YR 3/4	loam	weak	medium	subangular blocky	slightly hard	<10	neutral
BCk	27–45+	white 10YR 8/2	grayish brown 10YR 5/2	loam	weak	medium	angular blocky	hard	<10	moderately alkaline

Analyses: Brenda series

Horizon	Depth inches	pH in H_2O	Organic matter %	Fe	Al	Particle size distribution %			
						Sand	Silt	Clay	Fine clay
Ah1	0–4	5.9	6.4	0.7	0.3	51.1	38.7	10.2	2.3
Ahe1	4–6	6.4	6.4	0.6	0.4	51.1	38.7	10.2	3.4
Ahe2	6–15	6.9	3.1	1.3	0.5	51.9	38.8	9.3	2.6
Bm	15–23	6.8	3.1	0.5	0.4	53.1	38.4	8.5	2.9

BRITTON SERIES

The Britton soils are Orthic Gray Luvisols of the Britton catena. They have L–H horizons, grayish brown loam Ahe and Ae horizons, and brownish gray AB horizons over clay loam Bt horizons. The C horizons are reddish brown and moderately fine textured.

Type location: 49°48.8′ N 120°42.6′ W.

Range in characteristics: The solum is 20 to 40 inches thick. Gravel and cobbles occupy 5% to 20% of the profile. Fine and medium roots are concentrated mainly in the upper 12 to 18 inches. The A horizons are grayish brown or light brownish gray, slightly acid, loam or clay loam. The Bt horizon is 10 to 30 inches thick and is dark brown clay loam or clay. A Ck horizon occurs 30 to 50 inches under the surface.

Similar series: Connaly, Kane, and Selish soils are Gray Luvisols. Connaly lacks the reddish chroma and finer texture of Britton soils; both the Kane and Selish soils have lithic contacts within 20 inches of the surface.

Landform and climate: Britton soils occur on gently to strongly rolling till plains at elevations of 3400 to about 5000 feet. Parent materials are moderately fine textured, reddish brown, mildly alkaline tills that are derived mainly from, and overlie, hard reddish colored basalts. The climate is modified continental with an estimated annual precipitation of about 21 inches and mean annual temperatures of 38° F or less. There are less than 1650 growing degree-days and the frost-free period is less than 50 days.

Associated soils: Selish, a Lithic Gray Luvisol, and Coalmont, an Orthic Dark Gray soil, are in the Britton catena. Britton soils occur with Connaly and Kane soils.

Drainage and permeability: Well drained with moderate runoff and moderate to slow permeability.

Vegetation: Douglas-fir – pine grass habitat type, characterized by a moderately dense forest of Douglas-fir and lodgepole pine with buffaloberry, arnica, and twinflower in the understory.

Present use: Timber production of Douglas-fir and lodgepole pine; summer and fall grazing by cattle and wildlife.

Distribution and extent: The till plains and uplands west of Aspen Grove. Britton is the main soil on 82,000 acres.

Remarks: The Britton soil series was established in 1960 in the Tulameen map area of British Columbia.

Morphological description: Britton series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–H	0.5–0	leaves, needles, moss								
Ahe	0–1.5	grayish brown 10YR 5/2	dark grayish brown 10YR 4/2	sandy loam	weak	medium	granular	friable	2–5	strongly acid
Ae	1.5–6	grayish brown 10YR 5/2	dark grayish brown 10YR 4/2	loam	moderate	coarse	granular	friable	2–5	slightly acid
AB	6–15	light brownish gray 10YR 6/1.5	dark grayish brown 10YR 4/2	loam	moderate	medium	subangular blocky	friable	<5	slightly acid
Bt1	15–28	pinkish gray 7.5YR 5.5/2	dark brown 7.5YR 4/3	light clay loam	strong	medium	subangular blocky	hard, firm	5–10	slightly acid
Bt2	28–39	pinkish gray 7.5YR 5.5/2	dark brown 7.5YR 4/3	clay loam	strong	medium	subangular blocky	very hard, very firm	5–10	slightly acid
Ck	39+	pinkish gray 7.5YR 6/2	dark brown 7.5YR 4/3	light clay loam	moderate	fine	subangular blocky	firm	5–10	mildly alkaline

Analyses: Britton series

Horizon	Depth inches	pH in H_2O	Organic matter %	Fe	Al
Ae	1.5–6	5.6	3.1	1.5	0.2
AB	6–15	5.6	1.6	1.5	0.3
Bt1	15–28	5.4	1.5	1.5	0.4
Bt2	28–39	5.9	0.9	0.6	0.4
Ck	39+	6.3	0.4	0.6	0.3

BROMLEY SERIES

The Bromley soils are Orthic Gray Luvisols of the Thalia catena. They have thin L–F layers, light gray gravelly sandy loam Ae horizons, AB and BA horizons, and gravelly sandy clay loam Bt horizons.

Type location: Map sheet 92H/SE. 49°26.3′ N 120°17.4′ W.

Range in characteristics: The solum averages about 3 feet in thickness. The profile is very gravelly throughout. Ae horizons are 3 to 6 inches thick, light gray to light brownish gray gravelly sandy loam. B horizons are pale brown to pale yellow gravelly sandy loam to gravelly sandy clay loam. A Ck horizon occurs at about 3 feet. The reactions are slightly acid in surface horizons and mildly alkaline in the C horizons.

Similar series: Thalia soils lack argillic B horizons. Other Gray Luvisols occur on finer textured materials.

Landform and climate: Bromley soils occur on moderately sloping fans at elevations of 2300 to 3200 feet. Parent materials are coarse textured, moderately alkaline fan deposits. The semiarid climate is characterized by hot, dry summers and long, cold winters. The mean annual precipitation is 15 to 20 inches and mean annual temperatures are 38 to 42° F. The frost-free period is 75 to more than 90 days, and there are 1900 to 2150 growing degree days above 42° F.

Associated soils: The main associated soil in the catena is Thalia, a Degraded Eutric Brunisol. Bromley soils also occur with Asp, Riddell, and Alleyne soils.

Drainage and permeability: Well drained and moderately permeable.

Vegetation: Douglas-fir – pine grass habitat type, characterized by a moderately dense forest of Douglas-fir and lodgepole pine with pine grass, kinnikinnick, sedges, and flat-top spirea in the understory.

Present use: Mainly grazing by livestock and deer.

Distribution and extent: On local fans in the Otter, Allison, and Hayes valleys. Bromley occurs with Thalia soils on about 4000 acres.

Remarks: The Bromley soil series was established in the Princeton map area in 1960.

Morphological description: Bromley series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–H	0.5–0	litter of fir needles, roots, and twigs								
Ae	0–5	light gray to light brownish gray 10YR 7/2 to 6/2	dark grayish brown 10YR 4/2	gravelly sandy loam	moderate	fine	platy	friable	>20	slightly acid
AB	5–8	pale brown 10YR 6/3	grayish brown 10YR 5/2	gravelly sandy loam	moderate	coarse	platy	friable	>20	slightly acid
BA	8–12	pale brown 10YR 6/3	olive brown 2.5Y 4/4	gravelly loam	weak	medium	subangular blocky	hard	>30	neutral
Bt	12–24	pale brown 10YR 6/3	light olive brown to olive brown 2.5Y 5/4 to 4/4	gravelly sandy clay loam	moderate	medium	subangular blocky	hard	>40	neutral
BC	24–34	pale yellow 2.5Y 7/4	pale brown to brown 10YR 6/3 to 5/3	gravelly sandy clay	weak	fine	subangular blocky	friable	>40	mildly alkaline
Ck	34–42	light brownish gray 2.5Y 6/2	grayish brown 10YR 5/2	gravelly sandy clay loam	weak	medium	angular blocky	friable	>40	moderately alkaline
C1	42+	pale brown 10YR 6/3	grayish brown 10YR 5/2	gravelly loam	weak	medium	subangular blocky	friable	>40	mildly alkaline

BULL SERIES

The Bull soils are Gleyed Orthic Gray Luvisols of the Grant catena. They have thin L–F layers, light gray, strongly acid, fine sandy loam Ae horizons, and mottled clay loam Btg horizons. A transitional BCg horizon grades into a slightly acid sandy loam Cg horizon.

Type location: 49°45.6′ N 120°17.2′ W.

Range in characteristics: The solum is 30 to 40 inches thick. Gravel content is 15% to 20% throughout the profile. Bedrock occurs 4 feet or more under the surface. The Ae horizon is light gray to light brownish gray, fine sandy loam or loam, 9 to 12 inches thick. The loam to sandy clay loam Btg horizon has a similar color range but is almost twice as thick. Mottling is common and distinct in the upper part of the horizon. Mottles are few and fine in the sandy loam C horizon.

Similar series: Pefferle soils lack argillic B horizons. Grant soils are moderately well drained and have stronger chromas in the B horizon.

Landform and climate: Bull soils occur on nearly level to gently sloping parts of the plateau uplands at an elevation of 4600 to 5500 feet. Parent materials are moderately coarse and medium textured, slightly acid tills derived mainly from lavas, argillites, and schists. The climate is modified continental, characterized by more than 21 inches of annual precipitation and mean annual temperatures of 38° F or less. The frost-free period is less than 50 days and the growing season is 1200 to 1650 days above 42° F.

Associated soils: Grant and Gulliford soils are in the catena. Bull soils also occur with Pefferle, Mazama, Bankeir, and Etches soils.

Drainage and permeability: Imperfectly drained with rapid runoff and slow permeability.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense forest of lodgepole pine, Engelmann spruce, and subalpine fir, and a ground cover of blueberry, wintergreen, bunchberry, and twinflower.

Present use: Logging of spruce and lodgepole pine.

Distribution and extent: The uplands adjoining Pennask and Paradise lakes. Bull soils occur in the Grant catena on 4200 acres.

Remarks: The Bull soil series was established in the Tulameen map area in 1962.

Morphological description: Bull series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	1–0	pine needles and litter								
Ae	0–5	light gray 10YR 7/2	brown 10YR 5/3	fine sandy loam	moderate	fine	granular	firm	nil	strongly acid
Btgj	5–9	light gray 10YR 7/2	grayish brown 2.5Y 5/2	clay loam	moderate	medium	subangular blocky	firm	<10	strongly acid
Btg	9–17	light gray 2.5Y 7/2	grayish brown 2.5Y 5/2	clay loam	strong	coarse	subangular blocky	firm	<20	medium acid
BCg	17–28	light gray 2.5Y 7/2	grayish brown 10YR 5/2	loam	strong	coarse and medium	angular blocky	firm	<20	medium acid
BCgj	28–36	light gray 2.5Y 7/2	grayish brown 10YR 5/2	sandy loam	strong	coarse	angular blocky	firm	<20	slightly acid

Analyses: Bull series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	C:N ratio	Cation exchange, meq/100 g soil					Percent base saturation	Particle size distribution %		
						capacity	Ca	Mg	K	Na		Sand	Silt	Clay
Ae	0–5	5.1	3.4	0.06	31.9	12.2	4.9	1.0	0.5	0.2	53.6	37	45	18
Btgj	5–9	5.3	0.8	0.03	17.2	12.1	7.3	1.6	0.3	0.2	78.1	37	28	35
Btg	9–17	5.4	0.7	0.03	14.3	14.3	8.9	2.3	0.4	0.2	82.1	44	28	28
BCg	17–24	5.6	0.4	0.02	15.1	10.1	6.2	1.9	0.3	0.2	85.9	47	31	22
	24–28	5.9	0.3	0.01	14.7	13.5	9.6	2.4	0.3	0.2	92.2	48	30	22
BCgj	28–36	6.4	0.1	0.01	11.6	7.5	6.7	0.6	0.2	0.2	100+	60	27	13

CHUWANTEN SERIES

The Chuwanten soils are Gleyed Alpine Dystric Brunisols of the Bonnevier catena. The soils have thick dark brown Ah horizons, mottled sandy loam Bmg horizons and BCg horizons.

Type location: Map sheet 92H/SE, 49°10.0′ N 120°45.0′ W.

Range in characteristics: The solum is 20 to 30 inches thick. Gravel content increases with depth. Bedrock occurs at 2 to 3 feet under the surface. Ah horizons are dark brown to very dark brown sandy loam to loam, 10 to 20 inches thick. The dark gray to olive-colored Bmg horizons have dark yellowish brown mottles concentrated along root channels. BCg horizons average about 20 inches thick.

Similar series: Bonnevier and Pitin soils have stronger chromas and lack the mottled B horizons of the Chuwanten soils.

Landform and climate: Chuwanten soils occur in saddles and on toe slopes. Elevations range from 5800 to 6500 feet. Parent materials are coarse textured, strongly acid till, colluvial, and aeolian deposits. The cold continental climate has a mean annual precipitation of about 30 inches and mean annual temperatures of about 28° F. The frost-free period is variable but is usually less than 30 days. Growing degree-days range from 1200 to less than 800 days above 42° F.

Associated soils: Bonnevier and Pitin soils are associated with Chuwanten soils in the Bonnevier catena.

Drainage and permeability: Imperfectly drained and slowly permeable.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by open cover of false-heather, moss-heather, blueberry, mountain valerian, arnica, grasses, forbs, and occasional conifer trees.

Present use: Mainly grazing by big game.

Distribution and extent: The highest parts of the Cascade Mountains and the Trepanege Plateau. Chuwanten soils occur with Bonnevier soils on about 1800 acres.

Remarks: The Chuwanten soil series was established in the Princeton map area in 1960.

Morphological description: Chuwanten series

Horizon	Depth inches	Color, moist	Texture	Structure			Consistence	Coarse fragments %	Reaction class
				Grade	Size	Form			
L–F	3–0	semidecomposed organic litter							
Ah1	0–2	very dark brown 10YR 2/2	loam	moderate	fine	granular	friable, plastic	nil	strongly acid
Ah2	2–10	very dark brown 10YR 2/2	loam	weak	medium	subangular blocky	friable, plastic	nil	strongly acid
Bmg	10–16	very dark gray to dark gray 5Y 3/1 to 4/1	sandy loam	weak	medium	subangular blocky	plastic	0–5	medium acid
BCg	16–36	dark gray to very dark gray 5Y 5/1 to 3/1	sandy loam	weak	medium	subangular blocky	plastic	5–10	medium acid

COALMONT SERIES

The Coalmont soils are Orthic Dark Gray Chernozemic soils of the Britton catena. The soils have organic L–H horizons and dark-colored A horizons. The brown Bt horizon is clay loam with a strongly developed subangular blocky structure. It overlies a Ck horizon.

Type location: 49°50.8′ N 120°42.3′ W.

Range in characteristics: The solum is 30 to 40 inches thick. Bedrock may occur 3 to 4 feet below the surface. Gravel and cobbles occupy 5% to 20% of the profile. The A horizons are dark brown to dark grayish brown loam or sandy loam. The B horizon is brown loam or clay loam. A Ck horizon is generally present about 30 inches under the surface.

Similar series: Brenda soils, which are of the same subgroup, have a similar profile but have developed on till that lacks the strong chroma of Coalmont parent material. Darcy soils are coarser textured and more acid.

Landform and climate: Coalmont soils occur on moderate to steep, generally south- and west-facing slopes of till plains at elevations of 3400 to 4200 feet. The parent material is moderately fine textured, reddish brown, mildly alkaline till derived mainly from, and overlying, reddish colored basaltic rocks. The climate is semiarid with a mean annual precipitation of 15 to 21 inches and mean temperatures of 38° to 42° F. The frost-free period is 60 to 75 days, and the growing season ranges from 1650 to 1900 degree-days over 42° F.

Associated soils: Coalmont soils occur with Britton and Selish soils in the Britton catena. The Coalmont series is associated with Brenda, Connaly, Princeton, and Collett soils.

Drainage and permeability: Well drained with moderate runoff and moderate to moderately slow permeability.

Vegetation: Douglas-fir – Idaho fescue habitat type: open forest of ponderosa pine, Douglas-fir, and trembling aspen with a ground cover of saskatoon, bitter cherry, Idaho fescue, and bluebunch wheat grass.

Present use: Mainly grazing by livestock and deer, and winter range for deer.

Distribution and extent: Drumlinized till plains west of Aspen Grove. Coalmont soils occur in the Brenda catena on about 19,700 acres.

Remarks: The Coalmont soil series was established in the Tulameen map area in 1960.

Morphological description: Coalmont series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–H	1.5–0	grass and needle litter								
Ah	0–2	very dark grayish brown 10YR 3/2	black 10YR 2/1	loam	strong	fine	granular	soft	<5	
Ahe	2–6	dark brown 10YR 3/3 and dark grayish brown 10YR 4/2	very dark brown 10YR 2/2	loam	moderate	medium and fine	subangular blocky	friable	<5	moderately acid
AB	6–10	brown 10YR 4/3	dark brown 7.5YR 4/2	light clay loam	strong	fine	subangular blocky	firm	<5	moderately acid
Bt	10–18	brown 10YR 4/3	dark brown 7.5YR 4/2	clay loam	strong	medium	subangular blocky	firm	<15	slightly acid
BC	18–31	brown 10YR 4/3	dark brown 7.5YR 3.5/2	clay loam	strong	medium	angular blocky	firm	<20	neutral
Ck	31+		dark brown 7.5YR 3/2	clay loam	moderate		subangular blocky	firm	<20	moderately alkaline

COLEY SERIES

The Coley soils are Typic Mesisols of the Coley complex. The soils have thick, very dark brown, slightly alkaline Om horizons over dark brown, semidecomposed sedges. Lower horizons contain wood and root fragments in a dark brown, medium to strongly acid matrix of semidecomposed organic material.

Type location: 49°52.8′ N 120°37.7′ W.

Range in characteristics: The control section is more than 4 feet thick. The upper tier contains very dark brown semidecomposed roots and leaves of sedges and aquatic plants. Surface tiers are generally underlain by a layer of volcanic ash 1 to 1.5 inches thick. They are slightly alkaline and may contain marl. The dark brown lower tiers contain wood fragments and roots and are medium to strongly acid.

Similar series: The Etches soils are Terric Mesisols developed on strongly acid, organic deposits.

Landform and climate: Coley soils occur in depressions throughout the lower plateau. Parent materials are partially decomposed, neutral to acid plant remains. The climate is semiarid, characterized by a mean annual rainfall of 13 to 21 inches and mean annual temperatures of 38° to 42° F. The frost-free period is 60 to 90 days or more, and there are 1650 to 2150 growing degree-days above 42° F.

Associated soils: Coley soils occur with Manning, Bluey, and Thynne soils.

Drainage and permeability: Very poorly drained; rapidly permeable.

Vegetation: Wetland plant communities that include sedges, willows, reed grasses, redtop, and tall manna grass.

Present use: Most of the accessible Coley soils are used for stock grazing and hay production.

Distribution and extent: Valleys and uplands below 4500 feet. Coley soils cover about 5000 acres.

Remarks: The Coley soil series was established in the Princeton map area in 1960.

Morphological description: Coley series

Horizon	Depth inches	Kind of fiber	Broken face	Rubbed	Pressed wet	Sodium pyrophosphate test	Structure
L	0–3	loose litter					
Oml	3–8	roots and leaves of sedges	10YR 2/2	10YR 3/3.5	10YR 3/1	10YR 4/3	medium to fine
Om2	8–13	roots and leaves	10YR 2/2	10YR 2/2	10YR 2/2	10YR 4.5/4	fine
volcanic ash	13–14		10YR 7/1				
Om3	14–35	wood and roots	10YR 4/3	10YR 4/3	10YR 3/3	10YR 6/3	coarse and fine
Of	35+						

Analyses: Coley series

Horizon	Depth inches	pH in H_2O	pH in $CaCl_2$	Organic matter %	Total N %	C:N ratio	Cation exchange, meq/100 g soil: Capacity	Ca	Mg	K	Na	Ca/Mg	Bulk density	Sat'd water-holding capacity	Ash	Fiber
L	0–3	6.8	6.3	69.3	2.8	14.4	79.3	226.1	12.4	1.4	2.8	18.2	0.2	1093.7	22.9	46.4
Oml	3–8	6.8	6.5	85.1	3.5	14.1	127.3	144.9	17.7	1.2	2.6	7.9		717.4	28.9	47.9
Om2	8–13	6.3	5.9	64.0	2.4	15.8	158.0	141.2	19.0	1.2	2.1	7.5	0.3	584.7	32.7	31.5
volcanic ash	13–14			0.9	0.1	10.7	5.7	6.9	7.1	1.1	1.1	0.9				
Om3	14–35	6.1	5.8	99.4	2.9	19.9	186.2	161.3	24.8	1.3	2.2	6.1	0.2	758.0	17.9	66.5
Of	35+	5.4	5.2	83.7	2.7	17.9	183.6	159.9	22.3	1.3	1.9	7.2	0.2	1070.1	21.1	71.6

COLLETT SERIES

The Collett soils are Carbonated Rego Dark Gray Chernozemic soils of the Princeton catena. They have dark gray H horizons of decomposed organic matter. Light gray, strongly alkaline Ahek horizons overlie fine sandy loam Ck horizons.

Type location: Map sheet 92H/SE, 49°26.2′ N 120°30.2′ W.

Range in characteristics: The thickness of the solum to the upper boundary of the C horizon is 3 to 10 inches. Gravel is absent in the upper part of the profile but increases to 25% or more in the lower C horizons. Organic surface horizons are 3 to 6 inches thick. The gray sandy loam or loam A horizons are thin and strongly calcareous. They grade into gravelly sandy loam that is mottled along root channels.

Similar series: Corral soils, which occur south of the map area, are Carbonated Rego Dark Gray soils developed on moderately fine textured materials.

Landform and climate: Collett soils occupy gently sloping drainageways on drumlinized till plains. Parent materials are moderately coarse textured, mildly alkaline materials derived from, and underlain by, Cretaceous bedrock. Elevations range from 2400 to 3600 feet. The semiarid climate is characterized by 12 to 15 inches of annual precipitation and annual temperatures of 38° to 42° F. The frost-free period is 60 to 90 days or more, and there are 1650 to 2150 growing degree-days above 42° F.

Associated soils: Princeton, Separation, and Miner soils are associated soils in the catena. Collett soils also occur with Brenda soils.

Drainage and permeability: Moderately well drained and moderately permeable.

Vegetation: Kentucky blue grass, salt grass, spear grass, and sedges; occasional trembling aspen.

Present use: Summer range for livestock and deer.

Distribution and extent: The grasslands of the Princeton basin and Aspen Grove region. Collett soils occur mainly in the Princeton catena on about 5100 acres.

Remarks: The Collett soil series was established in the Tulameen map area in 1960.

Morphological description: Collett series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
H	5–0	dark gray 10YR 4/1	very dark brown 10YR 2/2	decomposed organic matter	weak	fine	subangular blocky	firm	nil	strongly alkaline
Ahek	0–3	light gray 10YR 5/1	dark grayish brown 10YR 4/2	loam	weak	medium	subangular blocky and granular	firm	nil	very strongly alkaline
Ckl	3–12	light gray 10YR 6/1	grayish brown 10YR 5/2	fine sandy loam	weak	medium	subangular blocky and granular	firm	nil	very strongly alkaline
Ck2	12–20	light gray 10YR 7/1	light brownish gray 10YR 6/2	fine sandy loam	weak	medium	angular blocky	firm	<2	very strongly alkaline
Ck3	20–24	light gray 10YR 6/1	dark gray 10YR 4/1	fine sandy loam	weak	medium	angular blocky	firm	<2	very strongly alkaline
Ckg	24+	light gray 10YR 7/2 and white 10YR 8/2	dark brown 10YR 4/3	gravelly sandy loam	weak	medium	subangular blocky	friable	>25	very strongly alkaline

CONNALY SERIES

The Connaly soils are Orthic Gray Luvisols of the Connaly catena. They have thin L–F horizons, thick brownish gray loam Ae horizons, transitional BA horizons, and sandy clay loam Bt horizons. The Ck horizon grades into loam till.

Type location: 49°45.7′ N 120°35.8′ W.

Range in characteristics: The solum is 30 to 55 inches thick. Moderate amounts of gravel and stones occur in the profile. Bedrock may occur at 30 inches but generally lies below 4 feet. The thick, sandy clay loam Bt horizon has a strongly developed structure. A Ck horizon generally occurs at 36 to 55 inches below the surface.

Similar series: Other Gray Luvisols in the area are Midday, Eastmere, and Shinish soils, which are developed on fine textured lacustrine deposits; Kane and Selish soils, which are lithic soils in which bedrock occurs 4 to 20 inches from the surface; and Grant soils, which have higher chromas in the surface horizons. Britton soils are developed on moderately fine textured, reddish brown till; Tulameen soils occur on moderately coarse textured, gravelly parent material. The parent materials of Bromley soils are moderately alkaline, colluvial fan deposits.

Landform and climate: Connaly soils occupy gently to strongly rolling till plains at elevations of 3200 to 4400 feet. Parent materials are moderately coarse and medium textured, slightly acid to neutral till derived from siliceous granites, granodiorites, and volcanic rocks. The semiarid climate has warm, dry summers, cold winters, and 15 to 21 inches of precipitation. Mean annual temperatures are 38° to 40° F. The frost-free period is 60 to 75 days, and the growing season is 1650 to 1900 degree-days above 42° F.

Associated soils: The lithic Kane soils are the main associates in the catena. Connaly soils occur with Brenda, Britton, Bankeir, Alleyne, and Coalmont soils.

Drainage and permeability: Well drained with moderate runoff and moderate permeability.

Vegetation: Douglas-fir – pine grass habitat type, characterized by a moderately dense forest of Douglas-fir and lodgepole pine over a ground cover of pine grass, buffaloberry, arnica, and twinflower.

Present use: Logging of Douglas-fir and lodgepole pine; late spring and summer grazing by livestock and deer.

Distribution and extent: Till plains surrounding Aspen Grove and the lower plateau regions throughout the area. Connaly is the main soil on 131,000 acres.

Remarks: The Connaly soil series was established in the Tulameen map area in 1960.

Morphological description: Connaly series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	1–0	grass and needle litter								
Ae	0–8	light brownish gray 10YR 6/2	dark grayish brown 10YR 4/2	loam	moderate	fine and coarse	granular	slightly hard to friable	<10	medium acid
BA1	8–16	grayish brown 10YR 5/2	dark grayish brown 10YR 4/2	loam	moderate	medium	subangular blocky	friable	<10	medium acid
BA2	16–26	brown 10YR 5/3	dark grayish brown 10YR 4.5/2	loam	strong	medium and coarse	subangular blocky	hard to friable	<10	slightly acid
Bt	26–40	grayish brown 10YR 5.5/2	dark grayish brown 10YR 4.5/2	sandy clay loam	strong	coarse	subangular blocky	very hard to very firm	<10	slightly acid
BC	40–55	dark grayish brown 10YR 4/2	very dark grayish brown 10YR 3/2	sandy clay loam	strong	coarse	angular blocky	very hard to very firm	<10	slightly acid
Ck	55+	light gray 10YR 6/1	dark brown 10YR 3/3	loam	strong	fine	subangular blocky	very firm	<10	moderately alkaline

Analyses: Connaly series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	C:N ratio	Cation exchange, meq/100 g soil					Percent base saturation	Particle size distribution %		
						Capacity	Ca	Mg	K	Na		Sand	Silt	Clay
Ae	0–4	6.0	1.91	0.06	18.5	12.18	6.92	1.35	0.54	0.16	73.7	46.3	37.4	16.3
	4–8	5.9	1.25	0.04	18.9	10.08	5.20	1.38	0.49	0.18	71.9	46.8	37.6	15.6
BA1	8–16	6.1	0.60	0.03	12.9	8.65	5.36	1.28	0.38	0.18	83.3	50.8	34.1	15.1
BA2	16–26	6.2	0.70	0.03	13.2	10.71	6.93	2.79	0.39	0.21	96.5	49.8	31.6	18.6
Bt	26–40	6.3	0.64	0.03	14.2	14.34	9.12	3.72	0.43	0.24	94.3	48.3	28.1	23.6
BC	40–47	6.5	0.58	0.02	14.1	15.46	11.02	3.55	0.35	0.26	98.3	47.8	27.2	25.0
	47–55	7.7	0.31	0.01	12.8	10.40	14.37	2.77	0.23	0.28	100+	49.3	29.7	21.0
Ck	55+	8.1		0.01	9.0	7.69	19.37	3.46	0.23	0.31	100+	53.8	27.7	18.5

COQUIHALLA SERIES

The Coquihalla soils are Mini Ferro-Humic Podzols of the Lawless catena. The soils have yellowish brown Ae horizons, dark brown to yellowish brown B horizons, and C horizons that are light olive brown sandy loam.

Type location: Cascade Mountains, approximately 49°21′ N 121°10′ W.

Range in characteristics: The solum is 2 to 3 feet thick. Gravel occurs throughout the profile, and bedrock may be present within 2 to 3 feet of the surface. The Ae horizon is thin yellowish brown sandy loam. The strong yellowish and reddish chromas of the B horizons grade into olive brown and sandy loam C horizons.

Similar series: Similar to other Podzols, but Nicomen and Lawless soils have less organic matter in the upper horizons.

Landform and climate: Coquihalla soils occur mainly on lower west-facing aspects of mountain slopes. Elevations range from 4000 to 5000 feet. Parent materials are coarse textured, acidic, colluvial, and till deposits. High winter snowfall, an annual precipitation of about 55 inches, and an annual temperature of 36° F characterize the climate.

Associated soils: Coquihalla soils are associated mainly with Lawless, Nicomen, and Skaist soils.

Drainage and permeability: Well to moderately well drained; moderately permeable.

Vegetation: Coastal hemlock zone, characterized by mountain hemlock, western red cedar, blueberries, forbs, and shrubs.

Present use: Timber harvesting.

Distribution and extent: Western slopes of the Cascade Mountains. Coquihalla soils occur in the Lawless catena on about 7400 acres.

Remarks: The Coquihalla soil series was established in the Princeton map area in 1969.

Morphological description: Coquihalla series

Horizon	Depth inches	Color		Texture	Reaction class
		Dry	Moist		
Ae	0–1	yellowish brown 10YR 5/4	grayish brown 10YR 5/2	sandy loam	extremely acid
Bhf1	1–4	dark brown 7.5YR 3/2	dusky red to dark reddish brown 2.5YR 3/2 to 3/4	sandy loam	extremely acid
Bhf2	4–8	yellowish brown 10YR 5/4 to 5/6	dark gray 5YR 4/1	sandy loam	very strongly acid
Bf	8–13	yellowish brown 10YR 5/4	dark brown 7.5YR 4/4	sandy loam	very strongly acid
C	@ 36	light olive brown 2.5Y 5/4	olive brown 2.5Y 4/4	sandy loam	medium acid

Analyses: Coquihalla series

Horizon	Depths inches	pH in $CaCl_2$	Organic matter %	Fe	Al
Ae	0–1	3.6	19.34	2.41	0.66
Bhf1	1–4	3.7	25.57	4.66	0.89
Bhf2	4–8	4.8	11.33	1.62	6.11
Bf	8–13	5.0	5.34	1.56	4.13
C	@ 36	5.9	0.88	0.43	0.54

CORBETT SERIES

The Corbett soils are Rego Dark Gray Chernozemic soils of the Howarth catena. The soils have thick dark gray silt loam Ahe horizons that grade into an AC horizon. The C horizons are calcareous and stratified.

Profile location: 49°59.5′ N 120°34.8′ W.

Range in characteristics: The solum is about 20 inches thick. Gravel is generally absent. Ahe horizons are dark gray to very dark grayish brown silt loam, 7 to 13 inches thick. The Ck horizon occurs at 6 to 20 inches below the surface.

Similar series: Howarth soils are Orthic Dark Gray Chernozemic soils with distinct B horizons.

Landform and climate: Corbett soils occur on gently rolling to hummocky lake basins at elevations of 3000 to 3500 feet. Parent materials are medium textured, moderately alkaline lake deposits of thin veneer silts and fine sands. The climate is semiarid. The mean annual rainfall is 13 to 21 inches and mean annual temperatures are 38 to 42° F. The frost-free period is 60 to 90 days or more, and the growing season is 1650 to 2150 degree-days above 42° F.

Associated soils: Corbett soils occur with Howarth soils in the Howarth catena.

Drainage and permeability: Well drained and moderately to slowly permeable.

Vegetation: Douglas-fir – Idaho fescue habitat type, characterized by an open forest of ponderosa pine, trembling aspen, and Douglas-fir and an understory of Idaho fescue, bluebunch wheat grass, forbs, and shrubs.

Present use: Grazing by livestock and deer.

Distribution and extent: Glacial lake basins in the northern part of the area. Corbett soils occur with Howarth soils on 7000 acres.

Remarks: The Corbett soil series was established in the Tulameen map area in 1960.

Morphological description: Corbett series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	0.25–0	grass and needles								
Ahe1	0–4	dark gray 10YR 4/1	very dark brown 10YR 2/2	silt loam	moderate	medium and fine	granular and platy	slightly hard	nil	mildly alkaline
Ahe2	4–13	dark gray 10YR 4/1	very dark grayish brown 10YR 3/2	silt loam	weak to moderate	medium	subangular blocky and prismatic	slightly hard to hard	nil	mildly alkaline
AC	13–20	dark grayish brown 10YR 4/2	very dark grayish brown 10YR 3/2	silty clay loam	moderate	coarse	subangular blocky	slightly sticky, plastic	nil	strongly alkaline
Ck1	20–30	grayish brown 10YR 5/2	dark grayish brown 10YR 4/2	silty clay loam	moderate	medium	subangular blocky	very sticky	nil	strongly alkaline
Ck2	30–60	light gray 10YR 6/1	dark grayish brown 2.5Y 4/2	silty clay loam and very fine sand	weak	medium	subangular blocky	sticky, plastic	nil	strongly alkaline

DARCY SERIES

The Darcy soils are Orthic Dark Gray Chernozemic soils of the Alleyne catena. They have thin F–H horizons, dark gray sandy loam Ahe horizons, and brown slightly acid loam Bm and BC horizons.

Type location: Map sheet 92H/SE, 49°26.3′ N 120°27.0′ W.

Range in characteristics: The solum ranges from 20 to 50 inches in thickness. Bedrock underlies the soil at 20 to 60 inches. The coarse skeleton makes up 5% to 20% of the profile. The A horizons are dark gray to dark grayish brown sandy loam or loam, 4 to 10 inches thick. The brown sandy loam or loam B horizons grade into a transitional BC horizon. The C horizon is loam or sandy loam, slightly acid to neutral. It commonly has an abrupt lower boundary on bedrock.

Similar series: Brenda, Coalmont, and Howarth are Orthic Dark Gray soils. The Brenda soil is developed on mildly alkaline, medium and moderately fine textured till. Parent materials of Coalmont soils are dark brown or dark reddish brown clay loams. Howarth soils are developed on lacustrine silts.

Landform and climate: Darcy soils occur on southern and western aspects of steep to very steep side slopes of major valleys. Parent materials are moderately coarse to medium textured, slightly acid to neutral colluvium and till. Elevations range from 3000 to 4500 feet. The climate is semiarid. The mean annual precipitation is 13 to 21 inches, and the annual mean temperatures are 38 to 42° F. The frost-free period is 60 to 90 days and the growing season ranges from 1650 to 2150 degree-days above 42° F.

Associated soils: Alleyne soils are the main associated soils in the catena. Darcy soils occur with Tulameen and Connaly soils.

Drainage and permeability: Well drained and moderately permeable, with slow runoff.

Vegetation: Douglas-fir – Idaho fescue habitat type, characterized by semi-open cover of ponderosa pine and Douglas-fir and an understory of bluebunch wheat grass, pine grass, Idaho fescue, balsamroot, and silky lupine.

Present use: Mainly winter range for deer; some summer cattle grazing; limited logging of ponderosa pine and Douglas-fir.

Distribution and extent: Valley slopes throughout the area. Darcy soils are part of the Alleyne catena that covers about 41,500 acres.

Remarks: The Darcy soil series was established in the Princeton map area in 1960.

Morphological description: Darcy series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
Ahe1	0–3	grayish brown 10YR 5/2	very dark grayish brown 10YR 3/2	sandy loam	weak, moderate	coarse, medium	platy, granular	friable	slightly stony	neutral
Ahe2	3–6	grayish brown 10YR 5/2	very dark grayish brown 10YR 3/2	sandy loam	weak, moderate	fine, medium	platy, granular	friable	slightly stony	neutral
Ahe3	6–10	light brownish gray 10YR 6/2	dark grayish brown 10YR 4/2	sandy loam	strong	medium	subangular blocky	friable	slightly stony	neutral
Aej	10–18	light brownish gray 10YR 6/2	dark grayish brown 10YR 4/2	sandy loam	moderate	coarse	subangular blocky	friable	slightly stony	neutral
Bt	18–24	light brownish gray 10YR 6/2	dark grayish brown 10YR 4/2	sandy loam	strong	medium	subangular blocky	friable	slightly stony	neutral
BC	24–39	light brownish gray 10YR 6/2	brown 10YR 4/3	sandy loam	moderate	coarse	subangular blocky	friable	slightly stony	neutral
Ck	39+	light brownish gray 2.5Y 6/2	grayish brown to dark grayish brown 2.5Y 5/2 to 4/2	sandy loam	weak	medium	platy and angular blocky	friable	moderately stony	moderately alkaline

Analyses: Darcy series

Horizon	Depth inches	pH in H_2O	Organic matter %	Fe	Al	Cation exchange, meq/100 g soil					Percent base saturation	Particle size distribution %			
						Capacity	Ca	Mg	K	Na		Sand	Silt	Clay	Fine Clay
Ahe1	0–3	6.9	4.10	.15	.09	13.59	14.24	1.41	0.98	0.06	100 +	55.9	35.8	8.3	2.6
Ahe2	3–6	7.2	2.29	.10	.09	12.92	11.87	1.48	0.93	0.04	100 +	55.9	34.6	9.5	3.5
Ahe3	6–10	7.3	2.02	.15	.08	12.07	11.07	1.54	0.88	0.04	100 +	56.0	34.7	9.3	2.3
Aej	10–18	7.3	0.64	.10	.09	9.64	8.52	1.35	0.83	0.04	100 +	59.4	32.0	8.6	1.1
Bt	18–24	7.3	0.82	.08	.10	9.47	8.53	1.42	0.62	0.03	100 +	61.5	26.1	12.4	4.6
BC	24–39	7.3	0.64	.06	.10	9.98	9.49	1.73	0.28	0.04	100 +	55.9	32.4	11.7	1.9
Ck	39+	8.6	0.19			6.92	17.19	2.52	0.18	0.13	100 +				

EASTMERE SERIES

The Eastmere soils are Brunisolic Gray Luvisols of the Eastmere catena. They have thin L–F layers, light gray Ae horizons, and very pale brown silty clay loam Bt horizons with a strongly developed structure. The C horizon is acidic silt loam.

Type location: 49°56.2′ N 120°19.2′ W.

Range in characteristics: The solum is about 30 inches thick. Gravel is absent and bedrock does not occur within 5 feet of the surface. The light gray Ae horizons are 5 to 8 inches thick, granular, and friable. The total thickness of the B horizons is 15 to 20 inches. They are light gray and pale brown clay loam and silty clay loam, and contain clay skins in the lower part of the horizon. The C horizons are light colored, stratified silt loam and very fine sandy loam.

Similar series: Grant soils are Brunisolic Gray Luvisols developed on till; Midday and Shinish are Orthic Gray Luvisols developed on mildly alkaline, fine textured lacustrine deposits.

Landform and climate: Eastmere soils occur on moderately to strongly rolling, dissected lake basins at elevations of 4500 to 5000 feet. Parent materials are medium textured, acidic deposits of silts and fine sands. The climate is continental, modified by maritime influence. Mean annual precipitation is 20 inches or more and mean annual temperatures are 38° or less. The frost-free period is less than 50 days and there are 1200 to 1650 growing degree-days above 42° F.

Associated soils: Eastmere soils occur with Boot soils in the catena.

Drainage and permeability: Moderately well drained and moderately to slowly permeable.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense forest of Engelmann spruce, lodgepole pine, and subalpine fir with an understory of blueberry, bunchberry, false-box, pine grass, and mosses.

Present use: Limited grazing by big game.

Distribution and extent: The Paradise Lake region. Eastmere soils predominate on 568 acres.

Remarks: The Eastmere soil series was established in the Tulameen map area in 1962.

Morphological description: Eastmere series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	1–0	pine needles and litter								
Bm	0–7	light gray 10YR 7/2	brown to dark brown 10YR 4/3	loam	moderate	fine	granular	friable	nil	medium acid
"C"	7–15	light gray 10YR 7/2	light brownish gray 2.5Y 6/2	clay loam	strong	medium	subangular blocky	firm	nil	strongly acid
Bt1	15–22	very pale brown 10YR 7/3	light olive brown 2.5Y 5/4	silty clay loam	strong	coarse to fine	subangular blocky	firm	nil	strongly acid
Bt2	22–30	very pale brown 10YR 8/4	light olive brown 2.5Y 5/4	silty clay loam	strong	medium	subangular blocky	firm	nil	strongly acid
C1	30–40	very pale brown 10YR 8/4	light olive brown 2.5Y 5/4	silty clay loam	strong	medium to fine	platy and subangular	friable	nil	medium acid
C2	40–54			silt loam						

Analyses: Eastmere series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	C:N Ratio	Fe	Cation exchange, meq/100 g soil					Percent base saturation	Particle size distribution %		
							Capacity	Ca	Mg	K	Na		Sand	Silt	Clay
Bm	0–7	5.6	2.1	0.06	21.7	0.7	17.9	6.0	2.0	0.7	0.0	48.8	30.0	45.0	25.0
"C"	7–15	5.4	0.4	0.02	10.6	0.7	19.3	12.2	3.5	0.6	0.1	84.6	28.0	39.0	33.0
Bt1	15–22	5.5	0.3	0.01	13.6		30.7	18.3	7.2	0.4	0.2	85.0	10.0	53.0	37.0
Bt2	22–30	5.5	0.1	0.01	6.8		32.6	18.3	7.9	0.4	0.2	82.3	15.0	49.0	36.0
C1	30–40	5.6	0.1	0.01	6.0	1.2	30.7	17.4	8.8	0.4	0.1	86.8	17.0	51.0	32.0
C2	40–54	6.0				0.2							23.0	62.0	15.0

ETCHES SERIES

The Etches soils are Typic Mesisols of the Etches complex. The soils have dark brown, very strongly acid, fibrous surface layers over thick, dark brown and black, mesic semidecomposed plant material.

Type location: Map sheet 92H/SE, 49°15.5′ N 120°19.0′ W.

Range in characteristics: Mineral soil underlies the organic materials at depths of 52 inches or more. The surface tier is dark brown and black fibrous peat and semidecomposed plant materials that are very strongly acidic. A layer of volcanic ash 1 to 3 inches thick usually occurs at 18 to 24 inches under the surface. The underlying mineral soil is sand or sandy loam.

Similar series: Coley soils are Typic Mesisols that occur at lower elevations; they have more alkaline surface horizons.

Landform and climate: Etches soils develop in depressions on the upland plateau. Parent materials are partially decomposed acidic plant matter. Elevations range from 4500 feet up into the alpine zone. The climate is modified continental with a mean annual precipitation of more than 20 inches and mean annual temperatures of 38° F or less. The frost-free period is less than 50 days and growing degree-days are 1650 to less than 1200 days above 42° F.

Associated soils: Etches soils occur mainly with Gulliford, Bull, Grant, and Henning soils.

Drainage and permeability: Very poorly drained and permeable.

Vegetation: Wetland plant communities that include sedges, grasses, willows, and Labrador tea.

Present use: Limited grazing by livestock and big game.

Distribution and extent: Throughout the upland plateau region of the area. Etches soils cover about 7200 acres.

Remarks: The Etches soil series was established in the Tulameen map area in 1969.

Morphological description: Etches series

Horizon	Depth inches	Kind of fiber	Color (broken face)	Reaction class
Of	0–4	litter of living sphagnum mosses and sedges		
Oml	4–12	well-decomposed mosses and sedges	10YR 2/2	very strongly acid
Om2	12–24	semidecomposed plant remains (mainly sedges)	10YR 3/2	very strongly acid
volcanic ash	24–25	(fine sand)		strongly acid
Om3	25–35+	semidecomposed sedge remains	10YR 3/2 to 3/3	very strongly acid

Analyses: Etches series

Horizon	Depth inches	pH in H_2O	Organic matter %
Oml	4–12	4.7	76.1
Om2	12–24	4.8	63.4
	24–25	5.2	10.8
Om3	25–35+	4.9	88.2

FAIRWEATHER SERIES

The Fairweather soils are Eluviated Black Chernozemic soils of the Fairweather catena. The soils have dark gray A horizons and brown Bt horizons that overlie calcareous parent material.

Type location: Map sheet 92 I/SE, 50°0.3′ N 120°25.0′ W.

Range in characteristics: The solum is about 3 feet thick. Gravel content increases with depth from 20% to more than 40%; occasional large boulders are present. The A horizons are neutral, dark gray to very dark grayish brown loam to sandy clay loam. The grayish brown to light grayish brown slightly acid to neutral B horizons of clay loam grade down into gravelly loam. A clay loam Ck horizon occurs at 30 to 42 inches.

Similar series: Separation soils are Cumulic Eluviated Black Chernozemic soils that occur on coarser textured, less alkaline till. The Princeton soils are Orthic Black Chernozemic soils with darker colored, sandy loam A horizons and coarser textured parent material. The dark gray Brenda soils lack a well-developed argillic horizon and occur on less alkaline till.

Landform and climate: Fairweather soils occur on strongly to steeply convex side slopes of drumlins and ridges of till plains. Parent materials are moderately fine to fine textured, moderately alkaline till. Elevations in the area range from 3500 to 3900 feet. The climate is semiarid with hot, dry summers and long, cold winters. The annual temperatures are 38° to 42° F and annual precipitation is 15 to 21 inches. The frost-free period is 75 to more than 90 days and the growing season is 1650 to 2150 degree-days above 42° F.

Associated soils: The main soil associated with Fairweather soils is Kullah, a Lithic Dark Brown soil.

Drainage and permeabiltiy: Well drained and moderately to slowly permeable.

Vegetation: Idaho fescue – eriogonum habitat type, which is a grassland community of Idaho fescue, bluebunch wheat grass, and tall white eriogonum.

Present use: Grazing by livestock and deer.

Distribution and extent: The grasslands in the northern part of the area. Fairweather is the main soil on 4600 acres.

Remarks: The Fairweather soil series was established in the Tulameen map area in 1969.

Morphological description: Fairweather series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
Ah	0–6	dark gray 10YR 4/1	black 10YR 2/1	sandy clay loam	moderate	medium	granular	hard, friable	<30	neutral
AB	6–9	very dark grayish brown 10YR 3/2	very dark brown 10YR 2/2	sandy clay loam	weak	medium	subangular blocky	hard, friable	<30	neutral
Bt	9–15	grayish brown 10YR 5/2	dark brown 10YR 3/3	clay loam	strong	medium	subangular blocky	hard, firm	<30	slightly acid
BC1	15–29	grayish brown 2.5Y 5/2	brown 10YR 4/3	gravelly loam	strong	medium	angular blocky	hard, firm	>40	slightly acid
BC2	29–42	light brownish gray 10YR 6/2	brown 10YR 4/3	gravelly loam	strong	medium	angular blocky	hard, firm	>40	neutral
Ck	42+	light brownish gray 2.5Y 6/2	brown 10YR 4/3	gravelly clay loam	strong	medium	angular blocky	firm	>40	moderately alkaline

Analyses: Fairweather series

Horizon	Depth inches	pH in H_2O	Organic matter %	Particle size distribution % Clay
Ah	0–6	6.9	5.2	24.6
Ahe	6–9	6.6	2.8	24.5
Bt	9–15	6.5	1.5	27.1
BC1	15–29	6.4	1.1	22.6
BC2	29–42	6.6	0.6	19.2
Ck	42+	8.0		

GALENA SERIES

The Galena soils are Orthic Dark Gray Chernozemic soils of the Galena catena. The soils have grayish brown A horizons overlying brown Bm horizons. A cobbly substrate underlies the solum.

Profile location: 49°29.0′ N 120°29.5′ W.

Range in characteristics: The solum is about 12 inches thick. Gravel content increases from 5% in the surface horizons to 50% or more in the lower B and C horizons. The sandy loam A horizons are dark gray and brown, and are about 8 inches thick. The brown, coarse textured B horizons are about 6 inches thick.

Similar series: Whipsaw soils have Ae horizons and thinner Ah horizons. Allison soils have thick, black Ah horizons.

Landform and climate: Galena soils occur on outwash terraces and deltas that are often kettled and hummocky. Elevations range from 2300 to 3500 feet. The climate is semiarid with an annual rainfall of 13 to 21 inches and mean annual temperatures of 38° to 42° F. The frost-free period is 75 to 90 days or more and there are 1900 to more than 2150 growing degree-days over 42° F.

Drainage and permeability: Rapidly drained and permeable.

Vegetation: Douglas-fir – Idaho fescue habitat type, characterized by an open forest of ponderosa pine and Douglas-fir with Idaho fescue, bluebunch wheat grass, fleabane, and silky lupine in the understory.

Present use: Grazing by livestock and deer.

Distribution and extent: Outwash terraces in the main valleys. Galena soils predominate on about 2800 acres.

Remarks: The Galena soil series was established in the Princeton map area in 1960.

Morphological description: Galena series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
Ah	0–1.5	dark gray 10YR 4/1.5	very dark brown 10YR 2/2	sandy loam	moderate	fine	granular	friable	<10	slightly acid
Ahe	1.5–6.5	brown 10YR 4/3	very dark grayish brown 10YR 3/2 and 2/2	sandy loam	weak	medium	granular	friable	<10	slightly acid
Bm	6.5–12	brown 10YR 5/3	dark brown 10YR 3/3	gravelly loamy sand	weak	fine	granular and single grain	loose	>30	neutral
IIC	12+	dark brown 10YR 4/3 (variegated color)		sand and gravel			single grain	loose	>50	neutral

GRANT SERIES

The Grant soils are Brunisolic Gray Luvisols of the Grant catena. They have thin L–H layers, pale brown sandy loam horizons, and light gray sandy clay loam Bt horizons.

Type location: 49°55.3′ N 120°17.0′ W.

Range in characteristics: The solum ranges from 30 to 55 inches in thickness. Gravel content averages 5% to 15%. Bedrock is 5 feet or more below the surface. The Bm horizons are pale brown to light gray sandy loam or loam, 12 to 25 inches thick. The Bt horizons are thick, light gray to light brownish gray sandy clay loam or clay loam. Illuvial clay occurs as coatings and bridges between mineral grains in the upper B horizon and as thick films in pores and channels in the lower B. The C horizon is slightly acid sandy loam to loam.

Similar series: Mazama soils lack the distinct argillic horizon of the Grant soils. Bull soils are mottled and have lower chromas throughout the solum.

Landform and climate: Grant soils occupy gentle slopes in the ridge and swale landform. Elevations range from 4600 to 5500 feet. Parent materials are moderately coarse and medium textured, slightly acid till derived mainly from lavas, argillites, and schists. The modified continental climate has warm, relatively dry summers, and long cold winters. Annual precipitation exceeds 21 inches, and mean annual temperatures are 38° F or less. The frost-free period is less than 50 days and the growing season is 1200 to 1650 days above 42° F.

Associated soils: Associated soils in the Grant catena are Bull, a Gleyed Orthic Luvisol, and Gulliford, a Rego Humic Gleysol. Grant soils occur with Mazama, Bankeir, Pefferle, and Etches soils.

Drainage and permeability: Moderately well drained with moderate runoff and moderately slow permeability.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense cover of lodgepole pine, Engelmann spruce, and subalpine fir with an understory of blueberry, wintergreen, bunchberry, and twinflower.

Present use: Logging of spruce and lodgepole pine.

Distribution and extent: The uplands near Pennask and Paradise lakes. Grant is the main soil on 4200 acres.

Remarks: The Grant soil series was established in the Tulameen map area in 1962.

Morphological description: Grant series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–H	1–0	leaves and pine needles								very strongly acid
Bm1	0–3	pale brown 10YR 6/3	dark yellowish brown 10YR 4/4	loam	weak	medium	granular	friable	<5	strongly acid
Bm2	3–11	pale brown 10YR 6/3	dark brown 10YR 4/3	fine sandy loam	weak	coarse	granular	friable	<7	medium acid
"C"	11–17	light gray 2.5Y 7/2	brown 10YR 5/3	sandy loam	moderate	medium	subangular blocky	firm	<10	strongly acid
Bt1	17–32	light gray 5Y 7/2	gray 10YR 6/1	sandy clay loam	moderate	medium	subangular blocky	firm	<7	strongly acid
Bt2	32+	light gray 5Y 7/2	grayish brown 2.5Y 5/2	sandy clay loam	moderate	coarse	subangular blocky	firm	<15	medium acid

Analyses: Grant series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	C:N ratio	Cation exchange, meq/100 g soil					Percent base saturation	Particle size distribution %		
						Capacity	Ca	Mg	K	Na		Sand	Silt	Clay
L–H	1–0	4.8	12.2	0.49	14.4									
Bm1	0–3	5.4	3.8	0.09	25.2	15.5	4.3	1.4	0.4	0.1	39.1	44.8	44.6	10.6
Bm2	3–11	5.6	2.3	0.07	18.1	10.8	1.7	0.9	0.3	0.1	27.1	52.5	38.0	9.5
"C"	11–17	5.5	0.5	0.03	11.4	6.9	3.6	0.8	0.3	0.1	69.3	58.2	27.0	14.8
Bt1	17–32	5.5	0.3	0.02	9.0	8.2	5.3	1.4	0.3	0.1	85.4	50.0	28.5	21.5
Bt2	32+	5.7	0.1	0.02	3.3	16.4	10.2	2.9	0.3	0.3	84.0	47.9	24.7	27.4

GULLIFORD SERIES

Gulliford soils are Rego Humic Gleysols of the Grant catena. They have thick, dark brown loam Ah horizons, mottled silty clay loam Cg horizons, and an underlying cobbly gravelly IIC horizon.

Type location: 49°57.0′ N 120°17.5′ W.

Range in characteristics: The solum is 15 to 30 inches thick. Gravel lenses may occur in the profile. Bedrock is 3 feet or more below the surface. A water table lies at or near the surface during most of the year. The loam or silt loam A horizons may be overlain by 6 to 12 inches of organic materials. Mottles are few and faint in the upper A horizon and generally become prominent in the lower solum. A gravel substrate occurs 15 to 30 inches under the surface.

Similar series: Etches and Coley soils are very poorly drained Organic soils.

Landform and climate: Gulliford soils occur in depressional positions of the ridge and swale landform. Elevations are 4600 to 5500 feet. Parent materials are moderately coarse to medium textured, slightly acid tills. Underlying bedrock includes lava, argillite, and schist. The modified continental climate is characterized by more than 21 inches of precipitation annually and mean temperatures of less than 38° F. The frost-free period is 50 days or less and the growing season ranges from 1200 to 1650 days above 42° F.

Associated soils: Gulliford soils are associated with Grant and Bull soils in the catena. They occur with Etches, Pefferle, Mazama, Lawless, and Nicomen soils.

Drainage and permeability: Poorly drained with rapid runoff and slow permeability.

Vegetation: Wetland plant community, characterized by sedges, forbs, and grasses; Engelmann spruce may be present.

Present use: Late summer grazing by big game and livestock.

Distribution and extent: Throughout the higher plateau regions Gulliford occurs mainly on the 4200 acres covered by the Grant catena.

Remarks: The Gulliford soil series was established in the Tulameen map area in 1962.

Morphological description: Gulliford series

Horizon	Depth inches	Color		Texture	Structure			Consistence
		Dry	Moist		Grade	Size	Form	
L–F–H	0.5–0	dead grass and leaves						
Ah1	0–4	very dark brown 10YR 2/2	black 10YR 2/1	loam	moderate	medium	subangular blocky	friable
Ah2	4–10	very dark gray 10YR 3/1	very dark gray 10YR 2/2	loam	weak	medium	subangular blocky	friable
Ah3	10–15	very dark gray 10YR 3/1	very dark brown 10YR 2/2	loam	moderate	medium	subangular blocky	friable
Cg	15–27	grayish brown 10YR 5/2	black 10YR 2/1	silt loam	moderate	medium	subangular blocky	firm
IIC	27+			cobbly gravel			single grain	loose

HASTINGS SERIES

The Hastings soils are Orthic Dark Gray Chernozemic soils of the Trehearne complex. The soils have organic L–F layers, dark gray sandy loam Ah and Ahe horizons, and thick brown Bm and Btj horizons that grade into gravelly sands at 6 feet.

Type location: Map sheet 92 I/SE, 50°00.8′ N 120°18.8′ W.

Range in characteristics: The solum has a thickness of 5 to 6 feet. Gravel, which is generally less than 5% in the solum, underlies the B horizon. Ah and Ahe horizons are dark gray to dark grayish brown sandy loam, 5 to 8 inches thick. Thick, pale brown to light olive brown Bm horizons overlie weakly developed, neutral Btj horizons that contain weak clay films and bridges.

Similar series: The Galena soils are Dark Gray Chernozemic soils that are shallow and lack Btj horizons.

Landform and climate: Hastings soils occur on hummocky channel and outwash deposits. Parent materials are moderately coarse, mildly alkaline sandy materials. The elevations range from 3700 to 4000 feet. The climate is semiarid, characterized by hot, dry summers and long, cold winters. The mean annual precipitation is about 15 to 20 inches and the mean annual temperatures are about 40° F. The frost-free period is 60 to 75 days and the growing season is 1650 to 1900 degree-days above 42° F.

Associated soils: Hastings soils occur with Trehearne, Shinish, and Allison soils in the complex.

Drainage and permeability: Rapidly drained and permeable.

Vegetation: Douglas-fir – Idaho fescue habitat type, characterized by an open forest of Douglas-fir and ponderosa pine with Idaho fescue and forbs in the understory.

Present use: Grazing by livestock and deer.

Distribution and extent: The Aspen Grove and Paradise Lake regions. Hastings soils occur on about 2000 acres.

Remarks: The Hastings soil series was established in the Tulameen area in 1962.

Morphological description: Hastings series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	1–0	litter of fir needles								
Ah	0–1.5	dark gray 10YR 4/1	very dark gray 10YR 2/2	sandy loam	moderate	coarse	granular	friable	<5	medium acid
Ahe	1.5–7	dark grayish brown 10YR 4/2	very dark grayish brown 10YR 3/2	sandy loam	moderate	coarse	granular	very friable	<5	medium acid
Bm1	7–12	brown 10YR 5/3	dark brown 10YR 3/3	fine sandy loam	moderate	very coarse and medium	granular	very friable, slightly plastic	<5	medium acid
Bm2	12–21	brown 10YR 5/3	dark brown 10YR 4/3	fine sandy loam	moderate	medium	subangular blocky	friable	<5	slightly acid
Bm3	21–38	pale brown 10YR 6/3	light olive brown 2.5Y 5/4	loamy sand	weak	coarse	angular blocky	friable	<5	neutral
Bm4	38–50	light brownish gray 2.5Y 6/2	olive brown 2.5Y 4/4	fine sandy loam	weak	coarse	angular blocky	friable, plastic	<5	neutral
IIBm	50–60	light olive brown 2.5Y 5/4	olive brown 2.5Y 4/4	sand	moderate	coarse	angular blocky	friable, nonplastic	<5	neutral
IIBtj	60–72	pale brown 10YR 6/3	olive brown 2.5Y 4/4	sand	moderate	medium	subangular blocky	friable, nonplastic	<5	neutral
IIC	72+	loose gravel								

HENNING SERIES

The Henning soils are Orthic Dystric Brunisols of the Henning catena. They have organic L–F horizons, pale brown, strongly acidic Bm horizons, and very coarse textured BC and C horizons.

Type location: 49°55.2′ N 120°17.9′ W.

Range in characteristics: The solum is 8 to 15 inches thick. Gravel content is 2% to 5% in the surface horizons and increases to more than 40% in the C horizon. The B horizons are pale brown to light yellowish brown sandy loam or gravelly sandy loam. The strongly acid C horizons are gravelly sand or loamy sand.

Similar series: Pasayten soils have podzolic B horizons; Asp soils are developed on alkaline outwash materials.

Landform and climate: Henning soils occur on outwash terraces, kames, and eskers that are often kettled and hummocky. Elevations range from 2900 to 5000 feet. Parent materials are coarse textured, strongly acid materials. The modified continental climate has warm, relatively dry summers and long cold winters. Precipitation is 15 to 20 inches annually and mean annual temperatures are 38° to 40° F. The frost-free period is 50 to 90 days and the growing season ranges from 1200 to 2150 days above 42° F.

Associated soils: Parawest soils are associated soils in the Henning catena. Pasayten soils occur with Henning soils.

Drainage and permeability: Rapidly drained and permeable.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense forest of lodgepole pine, Douglas-fir, and Engelmann spruce with an understory of pine grass, red alpine blueberry, and twinflower.

Present use: Mainly grazing by big game.

Distribution and extent: Mainly in the upland areas near Pennask Lake and Red Creek. Henning is the main soil on about 15,700 acres.

Remarks: The Henning soil series was established in the Tulameen map area in 1962.

Morphological description: Henning series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–H	1–0	fresh and decomposed needles								very strongly acid
Bm	0–12	pale brown 10YR 6/3	dark yellowish brown 10YR 4/4	sandy loam	weak to moderate	coarse	granular	friable	<3	strongly acid
IIBC	12–15	pale brown 10YR 6/3	grayish brown 2.5Y 5/2	gravelly sandy loam	weak	medium	subangular blocky	friable	>40	strongly acid
IIC	15–20	light gray 2.5Y 7/2	light olive brown 2.5Y 5/4	sand and gravel			single grain	loose	>50	strongly acid

Analyses: Henning series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	C:N ratio	Cation exchange, meq/100 g soil					Particle size distribution %		
						Capacity	Ca	Mg	K	Na	Sand	Silt	Clay
Bm	0–12	5.9	2.29	0.56	24.4	8.9	1.9	0.2	0.4	0.08	71	25	4
IIBC	12–15	5.2	0.75	0.30	14.3	7.6	3.3	0.3	0.4	0.08	78	14	8
IIC	15–20	5.5	0.25	0.12	12.5	6.9	4.2	1.3	0.3	0.07	90	6	4

HOWARTH SERIES

The Howarth soils are Orthic Dark Gray Chernozemic soils of the Howarth catena. The soils have thin L–H layers, dark gray loam and silt loam horizons, and brown Btj silty clay loam horizons that overlie BC and CB horizons.

Type location: 49°47.6′ N 120°38.1′ W.

Range in characteristics: The solum is 19 to 29 inches thick. The soils are often gravelly. Bedrock is generally more than 4 feet under the surface. The Ahe horizons average 8 inches thick and are dark gray to grayish brown loam to silt loam. The B horizons are 14 to 21 inches thick, grayish brown to pale brown silty clay loam. A Btj horizon is usually present. A Ck horizon occurs from 20 to 36 inches under the surface.

Similar series: Brenda, Coalmont, and Darcy soils are developed on till; Corbett soils lack B horizons; and Hastings soils are developed on coarse textured outwash materials.

Landform and climate: Howarth soils occur on gently rolling to hummocky lake basins. The elevation range is 3000 to 3500 feet. Parent materials are medium textured, moderately alkaline deposits of thin veneer silts and fine sands. The climate is semiarid, characterized by an annual precipitation of 13 to 21 inches and annual temperatures of 38° to 42° F. The frost-free period is 60 to 90 days and the growing season is from 1650 to 2150 degree-days above 42° F.

Associated soils: The main associated soil in the catena is Corbett.

Drainage and permeability: Well drained with slow runoff; moderately permeable.

Vegetation: Douglas-fir – Idaho fescue habitat type, characterized by ponderosa pine, trembling aspen, and Douglas-fir in open stands with a ground cover of Idaho fescue, bluebunch wheat grass, forbs, and shrubs.

Present use: Grazing by livestock and wildlife.

Distribution and extent: Glacial lake basins near Aspen Grove. Howarth soils occur on about 7000 acres.

Remarks: The Howarth soil series was established in the Tulameen map area in 1960.

Morphological description: Howarth series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–H	1–0	litter of leaves, needles and grass								
Ahe1	0–3	dark gray 10YR 4/1	very dark grayish brown 10YR 3/2	loam	moderate to strong	medium	prismatic and sub-angular blocky	hard	nil	slightly acid
Ahe2	3–8	dark grayish brown 10YR 4.5/2	very dark grayish brown 10YR 3/2	silt loam	moderate to strong	medium	prismatic and sub-angular blocky	hard	nil	neutral
Bm	8–12	grayish brown 10YR 5/2	very dark grayish brown 10YR 3/2.5	silt loam	weak to strong	medium	prismatic and subangular blocky	hard	nil	neutral
Btj	12–16	brown 10YR 5.5/3	dark brown 10YR 4.5/3	silty clay loam	strong	medium	subangular blocky	plastic	< 5	neutral
BC	16–29	pale brown 10YR 6/3	brown 10YR 5/3	silty clay loam	moderate	medium	angular blocky	plastic	nil	neutral
CB	29–35	pale brown 10YR 6/3	brown 10YR 5/3	silty clay loam	moderate	medium	angular blocky	plastic	nil	moderately alkaline
Ck	35–50	moderately calcareous, stratified, very fine sand and silt								moderately alkaline

ILTCOOLA SERIES

The Iltcoola soils are Gleyed Regosols of the Iltcoola complex. They have L–H organic horizons, loamy sand Ah horizons, and gleyed mottled Cg horizons.

Type location: Map sheet 92 H/SE, 49°27.8′ N 120°31.0′ W.

Range in characteristics: The solum consists of 6 to 10 inches of grayish brown Ah horizons that are neutral to moderately alkaline loamy sand. The Cg horizons are strongly mottled, light yellowish brown loamy sand that grades into olive brown sand and gravelly loamy sand. These soils generally remain moist throughout the growing season.

Similar series: The Boot and Parawest soils are Cumulic Regosols developed on finer textured materials.

Landform and climate: The Iltcoola soils occur on very gently sloping floodplains at elevations of 2500 to 3600 feet. Parent materials are very coarse textured neutral alluvium. The semiarid climate has hot, dry summers and long, cold winters. The annual precipitation is 13 to 21 inches; mean annual temperatures are 38° to 42° F. The frost-free period is more than 90 days and there are more than 2150 growing degree-days above 42° F.

Associated soils: Cumulic Regosols and Orthic Regosols occur in the complex with Iltcoola soils. Iltcoola occurs with Riddell, Manning, Coley, and Thynne soils.

Drainage and permeability: Imperfectly drained and highly permeable.

Vegetation: Variable plant communities containing cottonwood, willows, grasses, and forbs.

Present use: Limited use as grazing for livestock and deer; a source of gravel.

Distribution and extent: Valleys of the Similkameen and Tulameen rivers. In the Tulameen map area Iltcoola soils cover only 68 acres. They have a more extensive distribution south of the area.

Remarks: The Iltcoola soil series was established in the Princeton map area in 1960.

Morphological description: Iltcoola series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–H	2–0	organic litter, semidecomposed								slightly acid
Ah	0–6	grayish brown 2.5Y 5/2	olive brown 2.5Y 4/4	loamy sand	weak	fine	granular	friable	< 5	moderately alkaline
Cg	6–17	light yellowish brown 10YR 6/4	very dark grayish brown 2.5Y 3/2	loamy sand			single grain	loose	< 10	moderately alkaline
IIC	17–18	olive brown 2.5Y 4/4 and variegated colors		sand			single grain	loose	< 20	moderately alkaline
IICg	18–26		olive brown 2.5Y 4/4	sandy loam			single grain	loose	< 20	moderately alkaline
IIIC	26+	cobbly sand and gravel							> 50	

KANE SERIES

The Kane soils are Lithic Gray Luvisols of the Connaly catena. They have thin L and F–H layers over a brownish gray sandy loam Ae horizon, a transitional AB horizon, and a grayish brown loam Bt horizon that usually has a lower boundary on bedrock.

Type location: 49°49.0′ N 120°40.0′ W.

Range in characteristics: The solum is 4 to 20 inches thick over bedrock. Many large, angular rock fragments occur in the profile. The A horizon is loam, sandy loam, or very fine sandy loam and is 2 to 12 inches thick. The loam or clay loam B horizon is about 10 to 12 inches thick.

Similar series: Selish is a lithic soil developed on moderately fine textured, reddish colored till. Connaly soils are Orthic Luvisols.

Landform and climate: Kane soils occur on moderately to steeply sloping ridges of till plains. The elevations are 3200 to 4400 feet. The parent materials are moderately coarse and medium textured, slightly acid to neutral till that overlies granodiorite and volcanic rocks. The semiarid climate has warm, dry summers and cold winters. Annual precipitation is 15 to 20 inches and the mean annual temperature is 38° to 40° F. The frost-free period is 60 to 75 days and the growing season is 1650 to 1900 degree-days over 42° F.

Associated soils: Kane soils are associated with Connaly soils in the Connaly catena. They occur with Britton, Selish, Coalmont, and Brenda soils.

Drainage and permeability: Well to rapidly drained with moderate permeability.

Vegetation: Douglas-fir – pine grass habitat type, characterized by Douglas-fir and lodgepole pine in fairly dense stands over a ground cover of pine grass, buffaloberry, arnica, flat-top spirea, and kinnikinnick.

Present use: Limited use for grazing by livestock and deer; limited use for timber production.

Distribution and extent: Till plains near Aspen Grove and Tulameen. The Kane series occurs with Connaly soils on 116,000 acres.

Remarks: The Kane soils series was established in the Tulameen map area in 1960.

Morphological description: Kane series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Reaction class
		Dry	Moist		Grade	Size	Form		
L	1.5–1	needles and grass litter							
F–H	1–0	well-decomposed grass and leaves							
Ae	0–8	light brownish gray 10YR 6/2	dark brown 10YR 4/3	sandy loam	weak	fine	subangular blocky and granular	soft	neutral
BA	8–15	light brownish gray 10YR 6/2	dark brown 10YR 4/3	loam	weak	medium	subangular blocky	slightly hard, slightly plastic	neutral
Bt	15–19	grayish brown 10YR 5/2.5	dark brown 10YR 3/3	loam	strong	medium	subangular blocky	firm, plastic, sticky	mildly alkaline
R	19+	rock							

KULLAH SERIES

The Kullah soils are Lithic Dark Brown Chernozemic soils of the Fairweather catena. They have dark grayish brown sandy loam Ah horizons, and brown sandy loam Bm horizons. The C horizons overlie consolidated bedrock.

Type location: Map sheet 92 I/SE, 50°07.2′ N 120°27.5′ W.

Range in characteristics: The solum is 4 to 18 inches thick. Gravel occurs in all horizons and increases to more than 50% near the lithic contact. The A and B horizons are dark grayish brown to brown sandy loam to loam, 10 to 15 inches thick. The C horizon is yellowish brown gravelly sandy loam or sandy clay loam.

Similar series: Miner soils are Rego Dark Brown soils that lack B horizons.

Landform and climate: Kullah soils occur on irregular, strongly sloping crests of ridges in the till plain. Parent materials are moderately fine to medium textured, moderately alkaline till. Elevations range from 3500 to 3900 feet. The climate is semiarid with hot, dry summers and long, cold winters. The annual temperatures are 38° to 42° F and annual precipitation is 15 to 21 inches. The frost-free period is 75 to more than 90 days and the growing season is 1650 to 2150 degree-days above 42° F.

Associated soils: Kullah soils are associated with Fairweather soils.

Drainage and permeability: Well to rapidly drained and moderately permeable.

Vegetation: Idaho fescue – eriogonum habitat type, which is a grassland community of Idaho fescue, bluebunch wheat grass, and tall white eriogonum.

Present use: Grazing by livestock and deer.

Distribution and extent: The grasslands north of Aspen Grove. Kullah soils occur on 4600 acres of the Fairweather catena.

Remarks: The Kullah soil series was established in the Merritt area in 1969.

Morphological description: Kullah series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
Ah	0–2	dark grayish brown 10YR 4/2	very dark brown 10YR 2.5/2	sandy loam	weak	medium to fine	granular	soft, friable	<20	slightly acid
Bm	2–13	brown 10YR 4/3	very dark grayish brown 10YR 3/2.5	sandy loam	weak	fine and medium	granular	soft, friable	<30	neutral
C	13–15	yellowish brown 10YR 5/4	dark brown 10YR 3/3.5	gravelly sandy clay loam	weak	medium	subangular blocky	soft, friable	>50	neutral
R	15+	greenstone and andesite bedrock								

LAWLESS SERIES

The Lawless soils are Mini Humo-Ferric Podzols of the Lawless catena. They have thick L, F, and H horizons, a thin discontinuous Ae horizon, and a yellowish brown Bf horizon that is strongly to medium acid.

Type location: Map sheet 92 H/SE, 49°23.8′ N 120°48.2′ W.

Range in characteristics: The solum is 10 to 20 inches thick. Gravel content increases with depth. Bedrock occurs at depths of 5 feet or more. The very thin Ae horizons are light brownish gray to light gray fine sandy loam. The B horizons are 9 to 18 inches thick and fine sandy loam to loam. The C horizons are medium acid to slightly acid sandy loam.

Similar series: These include Nicomen, Coquihalla, Mazama, and Wilbert soils. Nicomen soils have Ae horizons that are 1 inch thick or more; Coquihalla soils have stronger chromas and upper B horizons that contain more than 10% organic matter; Mazama and Wilbert soils have B horizons that do not meet the requirements of a podzolic B.

Landform and climate: The Lawless soils occur on mountain slopes and ridges of high and moderate relief. Elevations range from 4000 to 6000 feet. Parent materials are very coarse and moderately coarse textured, slightly and moderately acid colluvial and till deposits. The maritime influence on the climate results in high winter snowfall and mean annual precipitation of about 55 inches. The mean annual temperature is about 36° F.

Associated soils: The main associated soils in the catena are Nicomen, Skaist, and Coquihalla soils.

Drainage and permeability: Well drained and moderately permeable.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense forest of subalpine fir, lodgepole pine, mountain hemlock, Engelmann spruce, red alpine blueberry, twinflower, and arnica.

Present use: Mainly logging.

Distribution and extent: The Cascade Mountains and Trepanege plateau. Lawless soils predominate on about 139,200 acres.

Remarks: The Lawless soil series was established in the Princeton map area in 1960.

Morphological description: Lawless series

Horizon	Depth inches	Color Dry	Color Moist	Texture	Structure Grade	Structure Size	Structure Form	Consistence	Coarse fragments %	Reaction class
L	5.5–5	raw needles and litter								
F	5–1	decaying wood and organic materials								
H	1–0	well-decomposed organic matter								
Ae	0–0.5	light gray 10YR 7/2	gray 10YR 5/1	sandy loam			single grain	loose, nonsticky	nil	very strongly acid
Bf1	0.5–2	yellowish brown 10YR 5/6	yellowish red 5YR 4/6	fine sandy loam	weak	fine	granular	friable, plastic	nil	very strongly acid
Bf2	2–6	light yellowish brown 10YR 6/4	yellowish brown 10YR 5/6	loam	moderate	fine	subangular blocky	friable, very plastic	< 5	medium acid
Bf3	6–9	light yellowish brown 10YR 6/4	yellowish brown 10YR 5/4	loam	moderate	fine	subangular blocky	friable, very plastic	< 5	medium acid
C1	9–22	light gray 5Y 7/2	light olive brown 2.5Y 5/4	sandy loam		medium and coarse	subangular blocky	firm, slightly sticky	< 20	medium acid
C2	22–48+	pale olive 5Y 6/5	light olive brown 2.5Y 5/4 to olive brown 2.5Y 4/4	loam	strong	coarse	subangular blocky	firm, sticky	< 20	slightly acid

Analyses: Lawless series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	Fe	Al	Cation exchange, meq/100 g soil capacity	Ca	Mg	K	Na	Particle size distribution % Sand	Silt	Clay
Ae	0–0.5	4.3	0.9	0.03	0.0	0.1								
Bf1	0.5–2	5.3	4.7	0.09	1.9	2.0								
Bf2	2–6	5.6	2.8	0.07	1.4	1.5	14.7	3.1	0.4	0.3	0.2	48.2	42.1	9.7
Bf3	6–9	5.8	2.3		1.0	0.9	14.6	5.7	1.1	0.3	0.2	43.8	39.9	16.3
C1	9–22	6.1	0.7		0.2	0.1	6.9	5.0	0.8	0.1	0.2	47.9	45.5	6.6
C2	22–48+	6.1	0.4		0.3	0.1	8.1	5.8	1.5	0.2	0.2	42.5	46.8	10.7

MANNING SERIES

The Manning soils are Humic Eluviated Gleysols of the Manning catena. They have grayish brown, sandy clay loam Ap and Ahe horizons over mottled Btg and Ckg horizons that are underlain by a gravelly sand substrate.

Type location: 49°37.3′ N 120°21.7′ W.

Range in characteristics: The solum is about 30 inches thick. Gravel in the profile is generally less than 5%. The A horizons are dark grayish brown and dark gray sandy clay loam, 15 to 20 inches thick. The Bt horizons are grayish brown sandy clay loam, about 10 inches thick. Distinct, prominent mottles occur in the A and B horizons. The Ckg horizon overlies loose sand and gravel at about 3 feet.

Similar series: Thynne and Gulliford soils are Gleysols that lack an argillic horizon. Bluey soils lack the thick Ah horizon of Manning soils.

Landform and climate: Manning soils occur on gently sloping stream terraces and aprons of fans. Elevations range from 2400 to 2900 feet. The parent materials are moderately fine textured, moderately alkaline alluvium. The semiarid climate has hot, dry summers and long, cold winters. The annual precipitation is 13 to 21 inches and mean annual temperatures are 38° to 42° F. The frost-free period is more than 90 days and there are more than 2150 growing degree-days above 42° F.

Associated soils: Manning occurs with Bluey, Thynne, Riddell, and Iltcoola soils.

Drainage and permeability: Poorly drained and moderately permeable.

Vegetation: Wetland plant communities containing cottonwood, willows, sedges, and grasses.

Present use: Where excessive wetness is not a limitation, the Manning soils produce pasture and forage crops under irrigation.

Distribution and extent: In major valleys of the Similkameen watershed. Manning is the main soil on about 3200 acres.

Remarks: The Manning soil series was established in the Princeton map area in 1960.

Morphological description: Manning series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
Ap	0–8		very dark grayish brown 10YR 3/2	sandy loam	moderate	coarse	subangular blocky and granular	friable	< 5	neutral
Ahe	8–12	dark grayish brown 10YR 4/2		sandy clay loam	moderate	medium	subangular blocky and granular	friable	< 5	mildly alkaline
Aeg	12–20	dark grayish brown 10YR 4/2 to dark gray 10YR 4/1	very dark grayish brown 10YR 3/2	sandy clay loam	weak	medium	subangular blocky	friable	< 5	neutral
Btg	20–29	grayish brown 10YR 5/2	dark grayish brown 10YR 4/2	sandy clay loam	moderate	medium	subangular blocky	plastic	< 5	mildly alkaline
Ckg	29–36	grayish brown 10YR 5/2	dark yellowish brown 10YR 3/4	sandy clay loam	moderate		massive	plastic	< 5	moderately alkaline
IIC	36+	loose gravel and sand							> 50	

MAZAMA SERIES

The Mazama soils are Degraded Eutric Brunisols of the Mazama catena. The soils have thin L–F layers, a thin distinct Ae horizon, a pale brown, fine sandy loam Bm horizon, and thick light gray BA horizons. The underlying Btj horizons contain some clay skins.

Type location: 49°56.7′ N 120°17.6′ W.

Range in characteristics: The solum is very thick, ranging from 60 to more than 72 inches. Gravel content is 5% to 20% and generally increases with depth. Bedrock lies below 6 feet. The very thin Ae horizon is light gray to light grayish brown loamy fine sand or fine sandy loam. The pale brown sandy loam Bm horizon is 6 to 12 inches thick; BA horizons are very thick, pale brown sandy loam overlying Btj horizons. These horizons consist of 6 or more fine bands that contain bleached sand grains and weak clay bridges. The slightly acid to neutral sandy loam parent material underlies the solum at depths of 5 feet or more.

Similar series: Alleyne, Thalia, and Trehearne soils are Degraded Eutric Brunisols developed on alkaline parent materials. Asp soils have thin sola overlying a cobbly substrate. Nicomen, Lawless, and Wilbert soils have higher chromas and lack Btj horizons. Pefferle, Grant, and Bull soils have gleyed and mottled profiles.

Landform and climate: Mazama soils occupy moderately to strongly sloping convex sides of ridges on drumlinized uplands. The elevation range is 4500 to 5500 feet. Parent materials are moderately coarse textured neutral till. Argillites and granodiorites underlie the soils and form the main constituents of the till. The climate is modified continental with a mean annual precipitation of 20 inches or more and an annual temperature of 38° F or less. The frost-free period is less than 50 days and there are 1200 to 1650 growing degree-days over 42° F.

Associated soils: Mazama soils are associated with Bankeir, a Lithic Eutric Brunisol, and Pefferle, a Gleyed Degraded Eutric Brunisol, in the Mazama catena. Mazama occurs with Gulliford, Grant, and Bull soils.

Drainage and permeability: Well drained, with slow runoff and moderate permeability.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a forest of subalpine fir, lodgepole pine, and Engelmann spruce and an understory of red alpine blueberry, twinflower, and arnica.

Present use: Logging of spruce and lodgepole pine.

Distribution and extent: Uplands east and south of Aspen Grove. Mazama is the main soil on 121,600 acres.

Remarks: The Mazama series was established in the Tulameen map area in 1962. It was formerly classified as Degraded Brown Wooded and Gray Forested.

Morphological description: Mazama series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	0.5–0	pine needles and twigs								
Ae	0–0.5	light brownish gray 10YR 6/2	very dark grayish brown 10YR 3/2	fine sandy loam			single grain	loose	nil	very strongly acid
Bm	0.5–10	pale brown 10YR 6/3	olive brown 2.5Y 4/4	fine sandy loam	weak	fine	subangular blocky	friable, nonsticky, nonplastic	<2	medium acid
BA1	10–20	light gray 2.5Y 7/2	grayish brown 2.5Y 5/2	sandy loam	weak	medium	angular blocky	firm, nonsticky, nonplastic	<5	medium acid
BA2	20–32	light gray 10YR 7/2	grayish brown 2.5Y 5/2	sandy loam	weak	medium	angular blocky	friable	<5	medium acid
BA3	32–45	light gray 2.5Y 7/2	brown 10YR 4/3	sandy loam	weak	medium	angular blocky	friable	<5	medium acid
Btj	45–61		dark grayish brown 2.5Y 4/2	sandy loam	moderate	medium	angular blocky	firm	<5	slightly acid
CB	61–72+		dark grayish brown 2.5Y 4/2 and grayish brown 2.5Y 5/2	sandy loam	weak	medium	angular blocky	friable	<5	slightly acid

Analyses: Mazama series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	C:N ratio	Cation exchange, meq/100 g soil					Particle size distribution %		
						capacity	Ca	Mg	K	Na	Sand	Silt	Clay
Ae	0–0.5	5.8	13.1	0.26	29.3	22.0	6.5	1.9	0.6	0.21			
Bm	0.5–4	5.8	3.0	0.07	26.0	8.1	2.9	0.4	0.2	0.05	59.0	31.0	10.0
	4–10	5.8	1.2	0.05	14.3	6.1	2.2	0.3	0.3	0.15	60.5	30.5	9.0
BA1	10–16	5.8	0.2	0.01	8.9	3.9	2.6	0.5	0.3	0.15	58.5	33.0	8.0
	16–20	5.9	0.1	0.01	8.7	3.7	2.3	0.6	0.2	0.02	61.5	31.5	8.0
BA2	20–32	5.8	0.2	0.01	14.2	3.6	3.0	0.3	0.2	0.15	67.5	28.5	4.0
BA3	32–45	5.9	0.1	0.01	13.5	4.5	3.8	0.6	0.2	0.15	60.0	32.0	8.0
Btj	45–61	6.4									57.5	28.5	14.0
CB	61–72	6.5									60.5	26.5	13.0

MIDDAY SERIES

The Midday soils are Orthic Gray Luvisols of the Midday catena. They have L–H layers over brownish gray very fine sandy loam Ae horizons that overlie brown clay loam and clay AB and Bt horizons. The parent material is stratified clay and very fine sand.

Type location: 49°48.8′ N 120°56.8′ W.

Range in characteristics: The solum has an average thickness of about 3 feet. Gravel is absent in the profile. The Ae horizon is 4 to 8 inches thick, light gray, very fine sandy loam or light clay loam. The brown B horizons are clay or silty clay and are 30 to 36 inches thick. A Ck horizon is generally present.

Similar series: Shinish soils are Orthic Gray Luvisols that occur on medium textured, mildly alkaline silts and fine sands. In ponding areas at higher elevations on the plateau. Eastmere soils occur on medium acid lake deposits.

Landform and climate: Midday soils occur in gently rolling lake basins, at elevations of 2400 to 2700 feet. Parent materials are fine textured and mildly alkaline. The climate is semiarid with a mean annual precipitation of 13 to 21 inches and mean annual temperatures of 38° to 42° F. The frost-free period is 90 days or more and the growing season is more than 2150 degree-days above 42° F.

Associated soils: Gleyed Gray Luvisol and Orthic Dark Gray soils occur in the Midday catena.

Drainage and permeability: Well drained and moderately to slowly permeable.

Vegetation: Douglas-fir – pine grass habitat type, characterized by a moderately dense forest of Douglas-fir, ponderosa pine, and trembling aspen, with buffaloberry and pine grass in the understory.

Present use: Mainly used for pasture and hay.

Distribution and extent: Glacial lake basins in the Coldwater River valley. Midday soils predominate on about 1700 acres.

Remarks: The Midday soil series was established in the Tulameen map area in 1960.

Morphological description: Midday series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–H	1–0	needles and grass								
Ae1	0–4	light brownish gray 10YR 6/2	brown 7.5YR 4/2	very fine sandy loam	strong	fine	platy	soft	nil	neutral
Ae2	4–8	light gray 10YR 7/1 and light brownish gray 10YR 6/2	brown 7.5YR 4/2	very fine sandy loam	moderate	medium	platy	slightly hard, friable	nil	neutral
AB	8–13	brown 7.5YR 4/2	dark brown 7.5YR 3/2	clay loam	weak and moderate	coarse and fine	platy and subangular blocky	firm	nil	neutral
Bt	13–18	brown 7.5YR 4/2	dark brown 7.5YR 3/2	clay	weak and strong	medium	columnar and subangular blocky	very firm	nil	neutral
BC	18–30	brown 10YR 5/3	dark brown 10YR 4/3	silty clay	strong	medium	subangular blocky	very firm	nil	neutral

MINER SERIES

The Miner soils are Lithic Rego Dark Brown Chernozemic soils of the Princeton catena. The soils have dark brown sandy loam Ah horizons and gravelly sandy loam and loamy sand AC horizons overlying bedrock.

Type location: Map sheet 92 H/SE, 49°28.7′ N 120°27.3′ W.

Range in characteristics: The solum is 4 to 20 inches thick. Gravel content is 30% or more in the solum, increasing near the lithic contact. The soils have dark brown to brown A horizons that are gravelly sandy loam or loam grading into cherty loamy sand.

Similar series: Kullah soils are Lithic Dark Brown Chernozemic soils with B horizons and a finer textured, more alkaline profile.

Landform and climate: Miner soils occupy abraded crests of ridges on the till plain. Parent materials are moderately coarse textured, mildly alkaline till derived from, and overlying, Cretaceous bedrock. Elevations range from 2400 to 3600 feet. The semiarid climate has an annual precipitation of 12 to 15 inches, and annual temperatures of 38° to 42° F. The frost-free period is 75 to 90 days or more, and there are 1650 to 2150 growing degree-days above 42° F.

Associated soils: Princeton, Separation, and Collett soils are associated with Miner soils in the Princeton catena. The Miner series occurs with Tulameen and Alleyne soils.

Drainage and permeability: Rapidly drained and very permeable.

Vegetation: Fescue – eriogonum habitat type, characterized by an open grassland of Idaho fescue, bluebunch wheat grass, tall white eriogonum, fleabane, and silvery lupine.

Present use: Some limited spring and fall grazing for livestock and deer.

Distribution and extent: The grasslands near the village of Princeton. Miner soils occur on about 5100 acres.

Remarks: The Miner soil series was established in the Princeton map area in 1960.

Morphological description: Miner series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
Ah1	0–2	dark brown to very dark grayish brown 10YR 3/3 to 3/2	black 10YR 2/1	gravelly sandy loam	weak	fine	granular	friable, nonsticky	> 30	slightly acid
Ah2	2–7	dark brown 10YR 3/3	very dark brown 10YR 2/2	gravelly sandy loam	weak	medium	granular	friable, nonsticky	> 40	slightly acid
AC	7–12	dark brown to brown 10YR 4/3 to 5/3	dark yellowish brown 10YR 3/4	gravelly loamy sand			single grain	loose	> 50	neutral
R	12+	lava and argillite rocks								

NICOMEN SERIES

The Nicomen soils are Orthic Humo-Ferric Podzols of the Lawless catena. The soils have thick L–F and H layers over light gray loamy sand Ae horizons, and yellowish brown Bfh and Bf horizons that overlie sandy loam C horizons.

Type location: Map sheet 92 H/SE, 49°23.8′ N 120°47.8′ W.

Range in characteristics: The thickness of the solum is 12 to 15 inches. Gravel is common in the profile. The Ae horizons are light gray, loamy fine sand and are 1 to 2 inches thick. The B horizons are yellowish brown to light yellowish brown sandy loam, about 12 inches thick. The light gray acidic C horizons generally overlie till at 2 to 2.5 feet from the surface.

Similar series: Lawless soils have thin or discontinuous Ae horizons; Coquihalla soils have upper B horizons that contain more than 10% organic matter; the B horizons of the Wilbert and Mazama soils do not meet the requirements of a podzolic B; and Pitin soils have distinct Ah horizons.

Landform and climate: Nicomen soils occur on mountain slopes and ridges of high and moderate relief. Elevations range from 4000 to 6000 feet. Parent materials are very coarse and moderately coarse textured, slightly and moderately acid colluvial and till deposits. The maritime influence on the climate results in a high winter snowfall and a mean annual precipitation of about 55 inches. The mean annual temperature is about 36° F.

Associated soils: The main catenary members are Lawless, Skaist, and Coquihalla soils.

Drainage and permeability: Well drained and moderately permeable.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense forest of subalpine fir, lodgepole pine, mountain hemlock, and Engelmann spruce, with blueberries, twinflower, and arnica in the understory.

Present use: Mainly logging.

Distribution and extent: The Cascade Mountains and Trepanege Plateau. Nicomen soils occur in the Lawless catena on about 131,800 acres.

Remarks: The Nicomen soil series was established in the Princeton map area in 1960.

Morphological description: Nicomen series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	2.5–1	needles, rotten wood, moss, and twigs								extremely acid
H	1–0	decomposed woody litter								extremely acid
Ae	0–2	light gray 10YR 7/1	light brownish gray 10YR 6/2	loamy fine sand			single grain	loose	< 5	extremely acid
Bfh	2–6	yellowish brown 10YR 5/4	yellowish red 5YR 4/6 and dark brown 7.5YR 4/4	sandy loam	weak	coarse	subangular blocky	friable, nonplastic	< 5	very strongly acid
Bf	6–12	light yellowish brown 10YR 6/4	yellowish brown 10YR 5/6	sandy loam	weak	fine and medium	subangular blocky	friable	< 5	medium acid
C1	12–26	light yellowish brown 10YR 6/4	yellowish brown 10YR 5/6	sandy loam						medium acid
C2	26–52			gravelly sandy loam	strong	medium	angular blocky			

Analyses: Nicomen series

Horizon	Depth inches	pH in H_2O	Organic matter %	Fe	Al
L–F–H	2.5–0	3.6	91.8	0.5	0.2
Ae	0–2	3.9	2.3	0.6	0.0
Bfh	2–6	5.0	6.4	0.5	1.7
Bf	6–12	5.7	0.8	0.3	1.0
C1	12–26	6.0	0.4	0.1	0.3
C1	@ 26	6.0	0.3	0.2	0.4
C2	@ 52	6.4	0.1	0.2	0.4

PARAWEST SERIES

The Parawest soils are Cumulic Regosols of the Henning catena. They have thick, yellowish brown very fine sandy loam AC horizons over C horizons that may include buried layers.

Type location: 49°56.0′ N 120°18.0′ W.

Range in characteristics: The profile is 8 to 12 inches thick and usually contains one or more buried horizons. Coarse fragments are generally absent in the profile. The pale brown to brownish gray A and C horizons are very fine sandy loam to loam.

Similar series: Boot soils are Cumulic Regosols developed on silty lacustrine sediments.

Landform and climate: Parawest soils occur on terraces, kames, and eskers that are often kettled and hummocky. Elevations range from 3000 to 5000 feet. Parent materials are moderately coarse textured, strongly acid outwash materials. The modified continental climate is characterized by warm, dry summers and long, cold winters. Precipitation is 15 to 20 inches annually and mean annual temperatures are 38° to 40° F. The frost-free period is 50 to 90 days and the growing season ranges from 1200 to 2150 degree-days above 42° F.

Associated soils: Parawest is associated with Henning soils.

Drainage and permeability: Moderately well drained and moderately permeable.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense forest of lodgepole pine, Engelmann spruce, and subalpine fir, with blueberries, bunchberry, false-box, and mosses in the understory.

Present use: Mainly grazing by big game.

Distribution and extent: Upland areas near Pennask Lake and Red Creek.

Parawest soils occur with Henning soils on about 15,700 acres.

Remarks: The Parawest soil series was established in the Tulameen map area in 1962.

Morphological description: Parawest series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	0–1	litter of needles and twigs								extremely acid
Ae	0–0.25	light gray 10YR 7/1	light gray 10YR 7/2	very fine sandy loam			single grain		nil	extremely acid
AC	0.25–10	very pale brown 10YR 7/3	yellowish brown 10YR 5/6	very fine sandy loam	strong	coarse	granular	soft, friable	nil	neutral
C	10–18	very pale brown 10YR 7/3	pale brown 10YR 6/3 and light yellowish brown 10YR 6/4	loamy very fine sand	moderate	medium	angular blocky	soft, friable	nil	medium acid
IIAhb	18–21	light brownish gray 10YR 6/2	very dark grayish brown 10YR 3/2	loam	moderate	medium	subangular blocky	slightly hard, friable	nil	medium acid
IIC	21–31	light gray 10YR 7/2	grayish brown 2.5Y 5/2	silty clay loam	moderate	medium	subangular blocky	hard, firm	nil	slightly acid

PASAYTEN SERIES

The Pasayten soils are Mini Humo-Ferric Podzols of the Pasayten catena. They have relatively thick organic L–H layers over thin Ae horizons that overlie yellowish brown loamy fine sand Bf horizons. The light gray BC horizons lie directly over gravelly loamy sand and sand.

Type location: Map sheet 92 H/SE, 49°03.8′ N 120°48.1′ W.

Range in characteristics: The solum is 8 to 10 inches thick. Gravel content increases from 15% to 20% in the upper horizons to more than 40% in the C horizon. The light brownish gray Ae horizons are less than 0.5 inches thick. The B horizons are very pale brown to light gray, strongly acid loamy fine sand. They grade into C horizons that are light gray gravelly loamy sand and strongly acid.

Similar series: Henning lacks the Ae and the podzolic B horizons of the Pasayten soils.

Landform and climate: Pasayten soils occur on gently to moderately sloping terraces. Elevations range from 3700 to 4300 feet. Parent materials are coarse textured, strongly acid outwash and alluvium. The climate has a mean annual precipitation of about 55 inches and a temperature of about 36° F.

Associated soils: Henning occurs with Pasayten soils.

Drainage and permeability: Well drained and permeable.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense forest of lodgepole pine, mountain hemlock, western red cedar, and spruce and an understory of red alpine blueberry, bunchberry, false-box, and mosses.

Present use: Logging of conifer species.

Distribution and extent: Valleys in the Cascade Mountains. Pasayten is the main soil on about 700 acres.

Remarks: The Pasayten soil series was established in the Princeton map area in 1960.

Morphological description: Pasayten series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Reaction class
		Dry	Moist		Grade	Size	Form		
L–H	1–0	living moss, decayed needles, twigs, and leaves							
Ae	0–0.5	light brownish gray 10YR 6/2	dark grayish brown 10YR 4/2	loamy fine sand	weak	medium	granular	friable, loose	very strongly acid
Bf	0.5–4	very pale brown 10YR 7/4	light yellowish brown 10YR 6/4	loamy fine sand	weak	medium	subangular blocky	friable	strongly acid
BC	4–8	light gray 10YR 7/2 and yellowish brown 10YR 5/4	grayish brown 10YR 5/2	loamy fine sand	weak	medium	subangular blocky	firm	strongly acid
C1	8–13	light gray 10YR 7/2	grayish brown 10YR 5/2	gravelly loamy sand			single grain	loose	strongly acid
C2	13–19	light gray 10YR 7/2	brown 10YR 4/3 to 5/3	gravelly loamy sand			single grain	loose	strongly acid
C3	19+		pale brown 10YR 6/3 and light yellowish brown 10YR 6/4	gravelly sand			single grain	loose	strongly acid

PEFFERLE SERIES

The Pefferle soils are Gleyed Degraded Eutric Brunisols of the Mazama catena. The soils have moderately thick L–F layers and thick, light gray, sandy loam Ae horizons. Strongly mottled, slightly acidic sandy loam Bg horizons overlie a Btjg horizon.

Type location: 49°56.1′ N 120°17.3′ W.

Range in characteristics: The solum is 40 or more inches thick. The gravel content varies from 5% to 15% in the profile, but may exceed 40% in some horizons. Bedrock lies below 5 feet. The light gray, fine sandy loam Ae horizons are 11 to 18 inches thick. Distinct fine mottles occur in the Bg horizons, which overlie a subhorizon containing some clay accumulation. The C horizon is weakly mottled sandy loam.

Similar series: Other Eutric Brunisols lack the mottling of Pefferle soils. Grant soils have distinct argillic horizons.

Landform and climate: Pefferle soils occupy concave slopes on drumlinized uplands. Elevations range from 4500 to 5500 feet. Parent materials are moderately coarse textured neutral till. Argillites and granodiorites underlie the soils and are the main components of the till. The climate is modified continental, characterized by a mean annual precipitation of 20 inches or more and a mean annual temperature of 38° F or less. The frost-free period is less than 50 days and there are 1200 to 1650 growing degree-days over 42° F.

Associated soils: Pefferle soils are associated with Mazama, a Degraded Eutric Brunisol, and Bankeir, a Lithic Eutric Brunisol, in the Mazama catena. Pefferle occurs with Gulliford, Grant, Bull, and Wilbert soils.

Drainage and permeability: Imperfectly drained with rapid runoff and moderately slow permeability.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense forest of Engelmann spruce, lodgepole pine, and subalpine fir and an understory of red alpine blueberry, bunchberry, wintergreen, and arnica.

Present use: Logging of spruce and lodgepole pine.

Distribution and extent: Plateau regions throughout the area. Pefferle soils occur in the Mazama catena on 121,600 acres.

Remarks: The Pefferle soil series was established in the Tulameen map area in 1962. It was formerly classified as Gleyed Gray Forested and Gleyed Brown Wooded.

Morphological description: Pefferle series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	1–0	moss, needles, and litter								
Ae1	0–8	light gray 2.5Y 7/2	grayish brown 2.5Y 5/2	sandy loam	strong	coarse	granular	friable	1–2	strongly acid
Ae2	8–11	light gray 2.5Y 7/1	grayish brown 2.5Y 5/2	sandy loam	moderate	coarse and medium	granular and subangular blocky	friable	<3	strongly acid
Bg1	11–18	light gray 2.5Y 7/2	grayish brown 2.5Y 5/2	sandy loam	weak	medium	subangular blocky	friable	<5	strongly acid
Bg2	18–37	light gray 2.5Y 7/2	grayish brown 2.5Y 5/2	sandy loam	moderate	medium	angular blocky	friable	<7	slightly acid
Btjg	37–42	light gray 2.5Y 7/2	grayish brown 2.5Y 5/2	sandy loam	moderate	coarse	angular blocky	firm	<7	neutral
Cg	42+		grayish brown 2.5Y 5/2	loamy sand	moderate	medium	subangular blocky	firm	<10	neutral

Analyses: Pefferle series

Horizon	Depth inches	pH in H_2O	Fe	Al	Particle size distribution %		
					Sand	Silt	Clay
Ae1	0–8	5.2			55.8	38.3	5.9
Ae2	8–11	5.3			60.1	35.1	4.8
Bg1	11–18	5.4			65.8	30.2	4.0
Bg2	18–37	6.5	0.5	0.1	64.6	31.3	4.1
Btjg	37–42	6.9	0.6	0.2	65.8	29.5	4.7
Cg	42–48	7.3	0.3	0.1	70.8	27.1	2.1

PITIN SERIES

The Pitin soils are Humo-Ferric Podzols with characteristics of the Sombric subgroup. The soils have brown turfy Ah horizons over brown or yellowish brown fine sandy loam horizons. The BC and C horizons are compact and stony.

Type location: 49°45.8′ N 120°03.6′ W.

Range in characteristics: The solum is 15 to 24 inches thick. Gravel content ranges from about 5% in the upper horizons to more than 40% in the C horizon. The Ah horizons are 3 to 9 inches thick, brown to dark brown fine sandy loam and sandy loam. Bf horizons are brown to pale brown sandy loam to gravelly sandy loam, 15 to 24 inches thick. The C horizons are pale brown gravelly sandy loam.

Similar series: Bonnevier soils are Alpine Dystric Brunisols with Bm horizons. Lawless and Nicomen series are Humo-Ferric Podzols that lack Ah horizons.

Landform and climate: Pitin soils occur on mountain ridges and slopes of low and moderate relief. Elevations range from 5800 to 6500 feet. Parent materials are coarse textured, strongly acid till, colluvial, and aeolian deposits. The cold continental climate has an annual precipitation of about 30 inches and mean annual temperatures of about 28° F. The frost-free period is variable but is usually less than 30 days. Growing degree-days range from 1200 to less than 800 days above 42° F.

Associated soils: Pitin soils occur with Bonnevier and Chuwanten soils in the Bonnevier catena.

Drainage and permeability: Well drained and permeable.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized mainly by an open cover of false-heather, moss-heather, red alpine blueberry, mountain valerian, and forbs.

Present use: Mainly grazing by big game.

Distribution and extent: The highest parts of the Cascade Mountains and the Trepanege Plateau. Pitin soils occur with Bonnevier soils on about 1800 acres.

Remarks: The Pitin soil series was established in the Tulameen map area in 1970.

Morphological description: Pitin series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	0.25–0	decomposed leaves and grasses								
Ah1	0–5	brown 10YR 5/3 and 4/3	dark brown 10YR 3/3	fine sandy loam	strong	fine	granular	friable	< 5	strongly acid
Ah2	5–9	brown 10YR 5/3	dark brown 10YR 4/3	fine sandy loam	strong and weak	medium and fine	granular and subangular blocky	friable	< 5	strongly acid
Bf1	9–18	brown 10YR 5/3	dark yellowish brown 10YR 4/4	fine sandy loam	moderate	coarse	subangular blocky	friable	< 5	strongly acid
Bf2	18–24	pale brown 10YR 6/3	yellowish brown 10YR 5/6	gravelly sandy loam	moderate	medium	subangular blocky	friable	> 75	strongly acid
C	24–30	pale brown 10YR 6/3	light olive brown 2.5Y 5/4	gravelly sandy loam	strong	medium	angular blocky	firm, hard	> 40	strongly acid
R	30+	angular granitic rock								

Analyses: Pitin series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	C:N ratio	Fe	Al	Cation exchange, meq/100 g soil					Particle size distribution %		
								Capacity	Ca	Mg	K	Na	Sand	Silt	Clay
Ah1	0–5	5.4	12.0	0.30	23.7	0.7	0.5	20.7	4.5	0.9	0.4	0.2	54.4	34.7	10.9
Ah2	5–9	5.3	7.3	0.22	19.3	0.8	0.6	15.2	1.8	0.6	0.2	0.1	56.7	34.0	9.3
Bf1	9–18	5.5	4.1	0.13	18.2	0.7	0.8	10.5	0.9	0.5	0.1	0.1	57.1	35.7	7.2
Bf2	18–24	5.5	2.5	0.09	15.5	0.8	0.7	7.6	0.7	0.3	0.1	0.1	65.6	28.1	6.3
C	24–30	5.5	0.6	0.03	12.6	0.3	0.2	4.8	1.3	0.0	0.1	0.1	55.8	33.6	10.6

PRINCETON SERIES

The Princeton soils are Orthic Black Chernozemic soils of the Princeton catena. The soils have black granular Ah horizons and brownish, slightly acid sandy loam B horizons. The sandy loam C horizon is mildly alkaline sandy loam till.

Type location: 49°30.0′ N 120°28.0′ W.

Range in characteristics: The thickness of the solum is 16 to 34 inches. Gravel is present in the profile and increases with depth. Weathered bedrock occurs at depths of 2 to 10 feet. The A horizons are 8 to 14 inches thick, black to very dark gray, slightly acid sandy loam and loam. The brown loam or sandy loam B horizons are 9 to 25 inches thick. A Ck horizon may occur.

Similar series: Separation, Fairweather, and Allison soils are Black Chernozemic soils; the first two have argillic horizons and the third has a solum overlying gravel. Brenda soils are finer textured; Collett soils are calcareous and lack B horizons.

Landform and climate: Princeton soils occupy well-drained positions on drumlinized till plains. Parent materials are moderately coarse and medium textured, mildly alkaline till derived from, and underlain mainly by, Cretaceous bedrock. Elevations range from 2400 to 3600 feet. The semiarid climate has an annual precipitation of 12 to 15 inches, and annual temperatures of 38° to 42° F. The frost-free period is 60 to more than 90 days and there are 1650 to 2150 growing degree-days above 42° F.

Associated soils: Separation, Miner, and Collett soils are associated with Princeton soils in the catena. Princeton occurs with Galena, Allison, Tulameen, and Alleyne soils.

Drainage and permeability: Well drained and moderately permeable.

Vegetation: Fescue–eriogonum habitat type, characterized by open grasslands of Idaho fescue, bluebunch wheat grass, tall white eriogonum, fleabane, and silvery lupine.

Present use: Spring and fall range for livestock and deer.

Distribution and extent: The grasslands near Princeton and Aspen Grove. Princeton soils occupy about 5100 acres.

Remarks: The Princeton soil series was established in the Princeton map area in 1960.

Morphological description: Princeton series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
Ah1	0–3	very dark gray 10YR 3/1	black 10YR 2/1	sandy loam	moderate	medium	granular	friable	<5	slightly acid
Ah2	3–10	very dark gray 10YR 3/1.5	black 10YR 2/1	sandy loam	strong	medium	granular	friable	<5	slightly acid
BA	10–14	dark grayish brown 10YR 4/2	dark brown 10YR 3/3	sandy loam	strong	medium	subangular blocky	hard	<7	slightly acid
Bm	14–19	brown 10YR 5/3	dark yellowish brown 10YR 4/4	sandy loam	strong	medium	subangular blocky	hard, friable	<20	neutral
BC	19–24	pale brown 10YR 6/3	olive brown 2.5Y 4/4	sandy loam	moderate	medium	angular blocky	hard, friable	<25	neutral
C1	24–42	light brownish gray 2.5Y 6/2		gravelly sandy loam	strong	medium	angular blocky	very hard, firm	>30	neutral
C2	42–72	light brownish gray 2.5Y 6/2	light olive brown 2.5Y 5/4 to olive brown 2.5Y 4/4	sandy loam	strong	coarse	angular blocky	hard, firm	<25	mildly alkaline
IIC	72+	light yellowish brown 10YR 6/4	yellowish brown 10YR 5/6	weathered Tertiary sediments						

Analyses: Princeton series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	C:N ratio	Fe	Al	Cation exchange, meq/100 g soil					Particle size distribution %		
								Capacity	Ca	Mg	K	Na	Sand	Silt	Clay
Ah2	3–10	6.3	8.3	0.3	16.0	0.5	0.5	21.0	12.0	1.3	1.0	0.3	57.0	34.1	8.9
Bm	14–19	6.8	1.1	0.1	10.3	0.6	0.2	10.4	6.6	1.4	0.4	0.3	63.7	28.1	8.2
BC	19–24	6.9	0.9	0.0	12.5	0.6	0.2	9.5	5.6	0.9	0.3	0.3	65.7	26.1	8.2
C1	24–42	7.2	0.5	0.0	14.0										
C2	42–72	7.5	0.4	0.0	10.0	0.3	0.2								

RIDDELL SERIES

The Riddell soils are Rego Dark Gray Chernozemic soils of the Riddell catena. The soils have grayish brown sandy loam Ahe horizons over a brown loamy sand Cl horizon. A Ck horizon overlies coarse sand and gravel at about 30 inches.

Type location: Map sheet 92 H/SE, 49°27.3′ N 120°21.6′ W.

Range in characteristics: The solum is 4 to 6 inches thick. Coarse fragments increase from 2% in the upper horizons to more than 50% in the C horizon. The A horizons are grayish brown to dark grayish brown sandy loams. The brown C horizon is loamy sand and mildly alkaline to moderately alkaline.

Similar series: Galena and Whipsaw soils have B horizons.

Landform and climate: Riddell soils occur on gently sloping terraces. Elevations range from 2400 to 2900 feet. Parent materials are moderately coarse and medium textured, moderately alkaline alluvium. The semiarid climate is characterized by hot, dry summers and long, cold winters. The annual precipitation is 13 to 21 inches; annual temperatures are 38° to 42° F. The frost-free period is greater than 90 days and there are more than 2150 growing degree-days above 42° F.

Associated soils: Riddell occurs with Manning, Bluey, Thynne, and Iltcoola soils.

Drainage and permeability: Well drained and permeable.

Vegetation: Variable plant communities that contain trembling aspen, Kentucky bluegrass, forbs, and grasses.

Present use: Riddell soils are the main arable soils of the valleys. They produce a wide variety of crops under irrigation.

Distribution and extent: Valleys of the Similkameen and Tulameen rivers. Riddell soils predominate on about 6000 acres.

Remarks: The Riddell soil series was established in the Princeton map area in 1960.

Morphological description: Riddell series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
Ahe1	0–2	dark grayish brown 10YR 4/2	very dark gray 10YR 3/1	fine sandy loam	weak	medium	granular	soft	nil	neutral
Ahe2	2–4	grayish brown 10YR 5/2	very dark grayish brown 10YR 3/2	sandy loam	weak	coarse	subangular blocky	soft	nil	neutral
C	4–15	brown 10YR 5/3		loamy sand			single grain	soft	<10	mildly alkaline
Ck	15–27	brown 10YR 5/3	grayish brown to dark grayish brown 10YR 5/2 to 4/2	fine sandy loam	weak	fine	angular blocky	soft	<10	moderately alkaline
IIC	27+	coarse sand and gravel					single grain	loose	>50	

Analyses: Riddell series

Horizon	Depth inches	pH in H_2O	Organic matter %	Cation exchange, meq/100 g soil					Percent base saturation	Particle size distribution %		
				Capacity	Ca	Mg	K	Na		Sand	Silt	Clay
Ahe1	0–2	6.8	6.0	21.2	15.7	3.6	1.2	0.3	98.5	69.8	23.5	6.7
Ahe2	2–4	6.9	1.9	14.1	9.8	3.8	0.7	0.2	100+	69.5	23.3	7.2
C	4–15	7.8	1.1	12.1	11.0	2.4	0.4	0.3	100+	78.6	15.6	5.8
Ck	15–27	8.4	1.8	12.4	20.3	5.1	0.2	0.4	100+	73.4	18.6	8.0

SELISH SERIES

The Selish soils are Lithic Gray Luvisols of the Britton catena. They have thin L–H layers over a pale brown loam Ae horizon and a transitional AB horizon. The pinkish gray clay loam Bt horizon has a lower boundary on consolidated bedrock.

Type location: 49°53.6′ N 120°41.0′ W.

Range in characteristics: The solum is 4 to 20 inches thick over granodiorite or volcanic rock. Coarse fragments increase with depth, but they occupy less than 20% of the soil volume. Textures of the A horizon are loam or clay loam; B horizons are clay loam or clay. Colors range from pale brown and grayish brown in the A horizon to light brownish gray and pinkish gray in the B horizons. The Bt horizon commonly lies directly on bedrock.

Similar series: Kane, a Lithic Gray Luvisol, is developed on coarser textured materials of lower chroma. Britton soils have thick sola.

Landform and climate: Selish soils occur on moderately to steeply sloping abraded ridges. The elevation range is 3400 to 5700 feet. The moderately fine textured till is reddish brown and mildly alkaline. The upper plateau has an annual precipitation of more than 21 inches and mean annual temperatures of less than 38° F. The frost-free period is less than 50 days and there are 1200 to 1650 growing degree-days above 42° F.

Associated soils: Selish soils occur in the catena with Britton, an Orthic Gray Luvisol, and Coalmont, a Dark Gray Chernozemic soil. The soils are associated with Connaly and Kane soils, and with Brunisolic Gray Luvisols at higher elevations.

Drainage and permeability: Well drained with moderate permeability.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense forest of lodgepole pine, Engelmann spruce, subalpine fir, and Douglas-fir with an understory of blueberries, arnica, false-box, and wintergreen.

Present use: Limited logging and grazing.

Distribution and extent: The till plains and uplands west of Aspen Grove. Selish occurs with Britton soils on 62,300 acres.

Remarks: The Selish soil series was established in the Tulameen map area in 1960.

Morphological description: Selish series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %
		Dry	Moist		Grade	Size	Form		
L–H	0.5–0	leaves, needles, moss							
Ahe	0–1	grayish brown 10YR 5/2	dark grayish brown 10YR 4/2	sandy loam	weak		granular	friable	nil
Ae	1–9	pale brown 10YR 6/3	brown 10YR 5/3	loam	weak	medium	subangular blocky	friable	<5
AB	9–12	light brownish gray 10YR 6/2	grayish brown 10YR 5/2	loam	moderate	medium	subangular blocky	friable	<10
Bt	12–20	pinkish gray 7.5YR 6/2	dark brown 7.5YR 4/2	clay loam	strong	medium	subangular blocky	hard, firm	>20
R	20+	rock							

SEPARATION SERIES

The Separation soils are Cumulic Eluviated Black Chernozemic soils of the Princeton catena. The soils have very dark grayish brown sandy loam Ah and Ahe horizons, grayish brown sandy clay loam Btj horizons, and loam Ck horizons.

Type location: 49°31.8′ N 120°28.8′ W

Range in characteristics: The solum is 3 to 4 feet thick. Gravel occupies 5% to 20% of the soil volume. Bedrock occurs below 4 feet. The A horizons are 9 to 20 inches thick and generally include some accumulated soil materials. The grayish brown B horizons have clay accumulation in the upper part, and grade with depth into light brownish gray loam. A Ck horizon occurs at 3 to 4 feet from the surface.

Similar series: Fairweather soils are Eluviated Black Chernozemic soils that occur on finer textured, more alkaline material. Princeton lacks eluvial and illuvial horizons and Brenda has grayer, more eluviated A horizons.

Landform and climate: Separation soils occupy the lower slope positions in the drumlinized till plain. Parent materials are moderately coarse textured, mildly alkaline till derived from, and underlain mainly by, Cretaceous bedrock. Elevations range from 2400 to 3600 feet. The semiarid climate has an annual precipitation of 12 to 15 inches, and mean annual temperatures of 38° to 42° F. The frost-free period is 60 to 90 days or more and there are 1650 to 2150 growing degree-days above 42° F.

Associated soils: Princeton, Miner, and Collett are associated with Separation soils.

Drainage and permeability: Moderately well drained and moderately permeable.

Vegetation: Fescue–eriogonum habitat type, characterized by open grasslands of Idaho fescue, bluebunch wheat grass, tall white eriogonum, fleabane, and silvery lupine.

Present use: Spring and fall range for livestock and deer.

Distribution and extent: The grasslands near Princeton and Aspen Grove. Separation soils occur on 5100 acres.

Remarks: The Separation soil series was established in the Princeton map area in 1960.

Morphological description: Separation series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
Ah	0–6	very dark gray 10YR 3.5/1	black 10YR 2/1	sandy loam	moderate	medium	subangular blocky	hard	< 5	neutral
Ahe	6–9	very dark grayish brown 10YR 3/2	very dark brown 10YR 2/2	sandy loam	weak	medium	subangular blocky	friable	< 5	neutral
Btj	9–15	grayish brown 10YR 5/2	dark brown 10YR 3/3	sandy clay loam	strong	medium	subangular blocky	firm	< 5	slightly acid
BC1	15–29	grayish brown 2.5Y 5/2	dark brown 10YR 4/3	loam	strong	medium	angular blocky	firm	< 10	slightly acid
BC2	29–42	light brownish gray 10YR 6/2	dark brown 10YR 4/3	loam	strong	medium	angular blocky	firm	< 10	neutral
Ck	42+	light brownish gray 2.5Y 6/2		loam	moderate	medium	angular blocky	firm	> 15	moderately alkaline

SHINISH SERIES

The Shinish soils are Orthic Gray Luvisols of the Trehearne complex. They have L–H layers, thick light brownish gray Ae horizons, and strongly developed silt loam Bt horizons. Thin strata of silt and fine sand occur in the Ck horizon.

Type location: 50°00.0′ N 120°21.0′ W.

Range in characteristics: The solum is 24 to 30 inches thick. Gravel content ranges from 7% to 15% in the profile. Pale brown to grayish brown are common colors in the Ae horizon; textures are loam or fine sandy loam. Thickness ranges from 10 to 15 inches. The B horizons are 10 to 15 inches thick, and are grayish brown loam or silty clay loam. A Ck horizon occurs at 20 to 30 inches.

Similar series: Midday soils are Orthic Gray Luvisols that occur on fine textured mildly alkaline materials. Eastmere soils have developed on medium acid deposits.

Landform and climate: Shinish soils occur in ponding basins associated with glacial meltwaters. Elevations range from 3700 to 4000 feet. Parent materials are medium textured, mildly alkaline silts and fine sands. The climate is semiarid, characterized by hot, dry summers and long, cold winters. The annual precipitation is 15 to 20 inches and mean annual temperatures are 38° to 42° F. The frost-free period is 60 to 75 days and there are 1650 to 1900 growing degree-days above 42° F.

Associated soils: The Shinish soils occur in the Trehearne complex with Trehearne, Hastings, and Allison soils.

Drainage and permeability: Well drained and moderately permeable.

Vegetation: Douglas-fir – pine grass habitat type, characterized by a moderately dense forest of Douglas-fir, trembling aspen, and lodgepole pine and an understory of pine grass, kinnikinnick, and buffaloberry.

Present use: Grazing by livestock and deer.

Distribution and extent: Limited distribution in the Quilchena River valley. Shinish soils occur in the Trehearne complex on about 2000 acres.

Remarks: The Shinish soil series was established in the Tulameen map area in 1962.

Morphological description: Shinish series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–H	1–0	pinegrass and needle litter								
Ahe	0–5	grayish brown 10YR 5/2	dark grayish brown 10YR 4/2	loam	moderate	medium	granular	friable	nil	medium acid
Ae	5–12	light brownish gray 10YR 6/2	grayish brown 10YR 5/2	loam	moderate	medium	granular	friable	nil	neutral
AB	12–15	grayish brown 10YR 5/2	grayish brown 10YR 5/2	loam	moderate	medium	subangular blocky	friable	nil	neutral
Bt1	15–17	light brownish gray 2.5Y 6/2	dark brown 10YR 4/3	loam	strong	medium	subangular blocky	hard, firm	nil	neutral
Bt2	17–22	grayish brown 2.5Y 5/2	gray to dark gray 10YR 5/1 to 4/1	silt loam	strong	medium	subangular blocky	hard, very firm	nil	mildly alkaline
BC	22–30	light brownish gray 2.5Y 6/2	grayish brown 2.5Y 5/2	silt loam	moderate	medium	platy and angular blocky	hard, very firm	nil	moderately alkaline
Ck	30+	light brownish gray 2.5Y 6/2		silt loam	moderate	fine	platy	firm	nil	strongly alkaline

SKAIST SERIES

The Skaist soils are Lithic Mini Humo-Ferric Podzols of the Lawless catena. They have thin Ae horizons over yellowish brown Bf horizons that overlie bedrock at depths of 20 inches or less.

Type location: Map sheet 92 H/SE, 49°16.8′ N 120°16.0′ W.

Range in characteristics: The solum is 4 to 20 inches thick over bedrock. Coarse fragments consitute 20% to 40% of the profile. The Ae horizon is 0.25 to 1 inch thick, or may be absent. The B horizons are yellowish brown to dark brown loamy sand, are 2 to 18 inches thick, and generally lie directly on bedrock.

Similar series: The lithic Bankeir soils lack the chroma and podzolic B horizon of the Skaist soils and are developed on moderately coarse textured, neutral till.

Landform and climate: Skaist soils occupy ridge positions in the plateau. Elevations are 4000 to 6000 feet. Parent materials are very coarse and moderately coarse textured, slightly and moderately acid colluvial and till deposits. The climate has high winter snowfall, a mean annual precipitation of about 55 inches, and an average mean annual temperature of about 36° F.

Associated soils: Skaist soils are associated with Lawless, Nicomen, and Coquihalla soils in the catena.

Drainage and permeability: Well drained with moderate permeability.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a moderately dense forest of Engelmann spruce, lodgepole pine, subalpine fir, mountain hemlock, false-box, red alpine blueberry, and mosses.

Present use: Some limited timber production.

Distribution and extent: The Cascade Mountains and Trepanege plateau regions. Skaist soils occur on about 118,500 acres.

Remarks: The Skaist soil series was established in the Princeton map area in 1960.

Morphological description: Skaist series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	1–0	litter of needles and moss								
Ae	0–1	white 10YR 8/2	gray 10YR 6/1	sandy loam	moderate	medium	granular	very friable	<10	very strongly acid
Bfh	1–2	very pale brown 10YR 7/4	yellowish brown 10YR 5/6	sandy loam	moderate	medium	granular	very friable	<10	very strongly acid
Bf	2–6	very pale brown 10YR 7/4	yellowish brown to light olive brown 10YR 5/6 to 2.5Y 5/6	sandy loam	weak	medium	subangular blocky	friable	<10	strongly acid
BC	6–14	white 10YR 8/2	light olive brown 2.5Y 5/4	loamy sand	weak	medium	subangular blocky	very friable	<15	medium acid
C1	14–20	very pale brown 10YR 7/4	yellowish brown 10YR 5/8	sandy loam	moderate	coarse	subangular blocky	firm	>20	medium acid
R	20+	weathered granitic rock								

Analyses: Skaist series

Horizon	Depth inches	pH in H_2O	Organic matter %	Fe	Al	Cation exchange, meq/100 g soil					Percent base saturation
						Capacity	Ca	Mg	K	Na	
Ae	0–1	4.1	4.2	0.3	0.1						
Bfh	1–2	4.9	5.2	0.6	1.5						
Bf	2–6	5.3	2.3	0.6	1.3	8.0	0.8	0.3	0.1	0.1	16.7
BC	6–14	6.0		0.5	0.4	2.5	0.8	0.7	0.1	0.1	65.3
C1	14–20	5.8				11.6	1.6	0.2	0.2	0.2	19.4

THALIA SERIES

The Thalia soils are Degraded Eutric Brunisols of the Thalia complex. They have thin L–H layers, dark grayish brown Aej horizons, and a gravelly sandy loam Bm horizon that overlies loamy sand and gravel.

Type location: 49°40.0′ N 120°47.2′ W.

Range in characteristics: The solum is about 12 inches thick. Gravel increases from about 15% in the surface to over 40% in the C horizon. The A horizons are dark grayish brown sandy loam, 2 to 5 inches thick. The Bm horizons are 6 to 10 inches thick, dark brown gravelly sandy loam. Mildly alkaline grayish brown gravelly and cobbly loamy sand occurs about 1 foot from the surface.

Similar series: Mazama, Alleyne, Asp, and Trehearne soils are Degraded Eutric Brunisols. Mazama and Alleyne occur on slightly acid and neutral colluvium and till. Asp has a very thin solum developed on neutral to slightly alkaline outwash materials; Trehearne is developed on very deep sandy deposits.

Landform and climate: Thalia soils occur on moderately sloping fans at elevations of 2300 to 3200 feet. Parent materials are very coarse and medium textured, moderately alkaline deposits. The semiarid climate is characterized by hot, dry summers and long, cold winters. The annual precipitation is 15 to 20 inches and annual temperatures are 38° to 42° F. The frost-free period is 75 to more than 90 days, and there are 1900 to more than 2150 growing degree-days above 42° F.

Associated soils: The main soils associated with Thalia are Bromley Orthic Gray Luvisols. Thalia occurs with Riddell and Alleyne soils.

Drainage and permeability: Well to rapidly drained and very permeable.

Vegetation: Douglas-fir – pine grass habitat type, characterized by a moderately dense forest of Douglas-fir and lodgepole pine, with pine grass, kinnikinnick, sedges, and flat-top spirea in the understory.

Present use: Some grazing by livestock; limited forage crop production under irrigation.

Distribution and extent: Main valleys in the plateau area. Thalia soil occurs on about 4000 acres.

Remarks: The Thalia soil series was established in the Tulameen map area in 1960.

Morphological description: Thalia series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Reaction class
		Dry	Moist		Grade	Size	Form		
L–H	1–0	semidecomposed needles and litter							
Aej	0–3	dark grayish brown 10YR 4/2	dark brown 10YR 3/3	sandy loam	moderate	medium	subangular blocky	firm	slightly acid
Bm	3–11	dark brown 10YR 4/3	dark brown 10YR 3/3	gravelly sandy loam	weak	medium	subangular blocky	friable	mildly alkaline
C1	11–22	grayish brown 10YR 5/2	dark grayish brown 10YR 4/2	loamy sand			single grain	loose	mildly alkaline
C2	22+	loamy sand, gravel, and cobbles coated with $CaCO_3$							

THYNNE SERIES

The Thynne soils are Rego Humic Gleysols of the Bluey catena. The soils have dark brown clay loam Ah horizons, a mottled sandy clay Cg horizon, and a gravel substrate at a depth of 30 inches.

Type location: 49°39.0′ N 120°46.3′ W.

Range in characteristics: The solum is 10 to 18 inches thick. Gravel is generally absent in the profile. The A horizons are dark brown to brown clay loam. The grayish brown Cg and Ckg horizons are sandy clay and overlie loose sand and gravel at 30 to 36 inches. Mottles are common and prominent in the C horizons.

Similar series: Gulliford and Bluey soils are Gleysolic; Gulliford soils are developed on moderately coarse, medium textured, slightly acid till, and Bluey soils have an argillic horizon.

Landform and climate: Thynne soils occur on level to gently sloping terraces at elevations of 2600 to 2900 feet. Parent materials are moderately fine textured, neutral alluvium. The climate is semiarid with hot, dry summers and long, cold winters. The annual rainfall is 13 to 21 inches, and annual temperatures are 38° to 42° F. The frost-free periods are more than 90 days and the growing season is more than 2150 degree-days above 42° F.

Associated soils: The main associated soils in the catena are Bluey soils, which are Low Humic Eluviated Gleysols. Thynne soils occur with Manning and Iltcoola soils.

Drainage and permeability: Poorly drained and very slowly permeable.

Vegetation: Wetland plant communities that include sedges, willows, and grasses.

Present use: Pasture and hay.

Distribution and extent: Confined mainly to the Otter Valley. The Thynne series occurs with Bluey soils on about 1600 acres.

Remarks: The Thynne soil series were established in the Tulameen map area in 1960.

Morphological description: Thynne series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
Ap	0–9	dark brown 10YR 4/3	very dark grayish brown 10YR 3/2	clay loam	moderate	medium	subangular blocky	friable	nil	slightly acid
Ah	9–18	brown 10YR 5/3	dark brown 10YR 3/3	clay loam	weak	coarse	granular	friable	nil	slightly acid
Cg	18–22		dark brown 10YR 4/3	sandy clay	weak	medium	subangular blocky	friable	nil	neutral
Ckg	22–30		grayish brown 10YR 5/2	sandy clay			massive		nil	moderately alkaline
IIC	30+	loose sand and gravel								moderately alkaline

TREHEARNE SERIES

The Trehearne soils are Degraded Eutric Brunisols of the Trehearne complex. They have L–H horizons, thick Ae horizons, and thick brown loamy sand Bm and Btj horizons. Weak accumulations of lime carbonate occur 7 to 8 feet from the surface.

Type location: 49°59.8′ N 120°20.6′ W.

Range in characteristics: The thickness of the solum is 6 to 8 feet. Gravel is generally absent in the profile. The Ae horizons are light gray or light brownish gray, slightly acid sandy loam and sand. The B horizons include a number of thin, firm bands that contain thin clay films on ped faces. The B and C horizons are pale brown to light brownish gray and neutral to mildly alkaline.

Similar series: Alleyne, Tulameen, Thalia, and Asp soils have several profile characteristics similar to Trehearne soils. The Alleyne series has a gravelly profile developed on colluvium or till; the Tulameen series has more distinct argillic horizons; the Thalia series has developed on gravelly deposits; and the Asp series has a thin solum overlying a gravelly substrate.

Landform and climate: Trehearne soils occur on deltas, terraces, and hummocky topography associated with glacial meltwaters. Elevations range from 3700 to 4000 feet. Parent materials are very coarse textured, neutral and mildly alkaline outwash materials. The climate is semiarid with hot, dry summers and long, cold winters. The annual rainfall is about 15 to 20 inches and annual temperatures are about 40° F. The frost-free period is 60 to 75 days and the growing period is 1650 to 1900 degree-days above 42° F.

Associated soils: Trehearne soils occur in complex with Hastings, Shinish, and Allison soils.

Drainage and permeability: Well drained and rapidly to moderately permeable.

Vegetation: Douglas-fir – pine grass habitat type, characterized by a moderately dense forest of Douglas-fir, trembling aspen, and lodgepole pine, with pine grass, kinnikinnick, and buffaloberry in the understory.

Present use: Mainly grazing by livestock and big game, with some logging.

Distribution and extent: Mainly in the Aspen Grove region. Trehearne soils occur on about 3200 acres.

Remarks: The Trehearne soil series was established in the Tulameen map area in 1962.

Morphological description: Trehearne series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Reaction class
		Dry	Moist		Grade	Size	Form		
L–H	2–0	dead grass, needles, and rotten wood							
Ael	0–5	light brownish gray 10YR 6/2	grayish brown to dark grayish brown 10YR 5/2 to 4/2	sandy loam	weak		granular	soft, friable	strongly acid
Ae2	5–17	light gray 2.5Y 7/2	grayish brown 2.5Y 5/2	sandy loam	strong	medium	subangular blocky	slightly hard, friable	slightly acid
Ae3	17–26	light gray 2.5Y 7/2	grayish brown 2.5Y 5/2	sand	moderate	medium	subangular blocky	slightly hard	slightly acid
Bm	26–38	pale brown 10YR 6/3	olive brown to light olive brown 2.5Y 4/4 to 5/4	loamy sand	strong		subangular blocky	hard, friable	neutral
Btj1	38–53	light brownish gray 2.5Y 6/2	grayish brown 2.5Y 5/2	sand	strong	medium	angular blocky	hard, friable	neutral
Btj2	53–79	grayish brown to light olive brown 2.5Y 5/2 to 5/4	dark grayish brown 2.5Y 4/2	sand	weak	coarse and medium	platy and angular blocky	slightly hard, friable	neutral
CB	79–90	light brownish gray 2.5Y 6/2	grayish brown 2.5Y 5/2	loamy sand	weak	medium	subangular blocky	friable	mildly alkaline
Ck	90+		grayish brown 2.5Y 5/2	loamy sand	weak	medium	subangular blocky	loose	moderately alkaline

Analyses: Trehearne series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	C:N ratio	Cation exchange, meq/100 g soil					Percent base saturation	Particle size distribution %		
						Capacity	Ca	Mg	K	Na		Sand	Silt	Clay
Ael	0–5	5.4	1.6	0.04	22.0	9.0	4.4	0.8	0.6	0.1	66.5	66.5	25.5	8.0
Ae2	5–17	6.2	0.5	0.02	11.6	5.4	3.8	0.1	0.4	0.1	81.2	73.0	22.9	4.1
Ae3	17–26	6.3	0.1	0.01	5.8	4.8	3.3	1.1	0.2	0.1	97.6	88.5	8.9	2.6
Bm	26–38	6.7	0.2	0.01	9.7	6.9	4.8	1.9	0.2	0.1	100.0	86.0	9.4	4.6
Btj1	38–38.75	6.5	0.4	0.02	13.6	11.4	5.7	3.8	0.4	0.1	89.1	86.0	4.9	9.1
	38.75–46	7.0	0.1	0.01	10.2	6.3	3.9	1.6	0.3	0.0	93.5	93.0	3.9	3.1
	46–47	6.6	0.2	0.01	10.2	11.6	5.5	6.1	0.1	0.0	100+	88.0	2.9	9.1
	47–53	7.1	0.1	0.01	6.8	5.9	3.0	2.9	0.2	0.0	100+	92.0	5.4	2.6
Btj2	53–66	7.0	0.2	0.01	7.9	8.9	4.3	4.6	0.2	0.0	100+	72.0	20.4	7.6
	66–69	6.9	0.1	0.01	7.5	5.7	2.5	4.1	0.2	0.0	100+	90.0	7.4	2.6
	69–79	6.8	0.1	0.01	4.5	7.7	3.8	3.5	0.3	0.0	99.5	78.0	15.9	6.1
CB	79–84	7.3	0.1	0.01	11.6	7.5	3.7	4.1	0.3	0.1	100+	83.0	11.4	5.6
	84–90	7.7	0.2	0.02	5.4	7.3	3.9	4.0	0.3	0.0	100+	78.5	16.9	4.6
Ck	90–100	8.3	0.1	0.01	6.8	5.7	5.5	3.6	0.2	0.0	100+	85.0	8.9	6.1

TULAMEEN SERIES

The Tulameen soils are Orthic Gray Luvisols of the Tulameen catena. The soils have thick grayish Ae horizons and very thick pale brown B horizons. Btj and BC horizons may extend to depths of more than 6 feet.

Type location: Map sheet 92 H/SE, 49°24.5′ N 120°31.0′ W.

Range in characteristics: The thickness of the solum ranges from 3 to 6 feet or more. Gravel content is about 15% in surface horizons, increasing to 30% in the BC horizons. The Ae horizons are 7 to 10 inches thick, grayish brown to pale brown sandy loam. The light gray to very pale brown B horizons are 30 to 40 inches thick. Textures range from sandy loam to loamy sand; clay skins occur in brownish colored areas of the horizon. Some clay skins extend into the CB horizon to depths of 8 feet or more. Reactions within the profile range from medium acid to neutral. Scattered pockets of lime carbonate occur in the lower CB horizon.

Similar series: Alleyne, Trehearne, Thalia, Asp, and Mazama soils belong to the Degraded Eutric Brunisol subgroup. Alleyne soils lack an argillic horizon; Trehearne soils have a thick sand or loamy sand solum containing a number of thin wavy bands deep in the subsoil; and Thalia soils have thin, dark grayish brown Ae or Aej horizons. Asp soils have sola 12 to 18 inches thick over cobbly gravel. Mazama soils have brown to dark brown Bm horizons.

Landform and climate: Tulameen soils occur on gently to moderately sloping plains with elevations of 2600 to 3400 feet. Parent materials are moderately coarse textured, neutral to mildly alkaline till and morainal gravels. The climate is semiarid with a mean annual precipitation of 13 to 20 inches. Summers are hot and dry, and winters are long and cold. The frost-free period is 75 to 90 days and the growing period ranges from 1900 to 2150 degree-days above 42° F.

Associated soils: Tulameen soils occur with soils of the Alleyne, Asp, Thalia, and Connaly series.

Drainage and permeability: Well drained and permeable.

Vegetation: Douglas-fir – pine grass habitat type, characterized by a moderately dense forest of Douglas-fir, ponderosa pine, and lodgepole pine, with pine grass, buffaloberry, kinnikinnick, and forbs in the understory.

Present use: Grazing by livestock and deer.

Distribution and extent: The Princeton basin area. Tulameen soils predominate on about 3900 acres.

Remarks: The Tulameen soil series was established in the Princeton area in 1960.

Morphological description: Tulameen series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	0.75–0	litter of needles and dead grass								
Ae1	0–7	white 10YR 8/2	grayish brown 10YR 5/2	sandy loam	weak	medium	granular	very friable	5–10	medium acid
Ae2	7–10	light gray 10YR 7/2	pale brown 10YR 6/3	sandy loam	moderate	medium and fine	granular	slightly hard	5–10	slightly acid
AB	10–14	light gray and yellowish brown 10YR 7/2 and 5/4	brown 10YR 5/3	sandy loam	moderate	medium	subangular blocky	hard, firm	10–15	slightly acid
Bt and Ae	14–30	very pale brown and yellowish brown 10YR 7/3 and 5/4	brown 10YR 5/3	sandy loam	strong	medium	subangular blocky	hard, firm	15–20	slightly acid
BC1	30–40	very pale brown and light yellowish brown 10YR 7/3 and 6/4	light yellowish brown and yellowish brown 10YR 6/4 and 5/4	gravelly loamy sand	weak	medium	subangular blocky	hard, firm	>30	neutral
BC2	40–52	pale brown and light yellowish brown 10YR 6/3 and 6/4	light yellowish brown and yellowish brown 10YR 6/4 and 5/4	gravelly loamy sand	moderate	medium and coarse	angular blocky	hard, firm	>30	slightly acid
CB	52–84	pale brown and light yellowish brown 10YR 6/3 and 6/4	dark grayish brown and brown 10YR 4/2 and 4/3	gravelly sandy loam	moderate	medium and coarse	angular blocky	hard, firm	>30	slightly acid

Analyses: Tulameen series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	C:N ratio	Fe	Al	Cation exchange, meq/100 g soil					Percent base saturation	Particle size distribution %		
								Capacity	Ca	Mg	K	Na		Sand	Silt	Clay
Ae1	0–4	5.95	1.35	.039	20.1	0.13	0.22	7.1	3.44	0.36	0.55		61.2	54.9	34.6	10.5
	4–7	5.88	0.68	.037	10.5	0.15	0.20	6.9	3.40	1.25	0.37		72.8	58.4	30.2	11.4
Ae2	7–10	6.11	0.29	.022	7.7	0.12	0.12	6.2	3.48	0.70	0.26	.02	72.0	59.5	29.2	11.3
AB	10–14	6.25	0.28	.012	13.3	0.10	0.12	6.2	4.06	0.66	0.18	.02	79.4	60.0	29.8	10.2
Bt and Ae	14–18	6.28	0.36	.013	16.1	0.12	0.10	7.4	4.38	1.14	0.21	.04	78.0	60.0	26.4	13.6
	18–23	6.42	0.44	.014	17.8	0.42	0.19	9.3	5.26	1.92	0.25	.04	80.4	66.2	22.6	11.2
	23–27	6.47	0.22	.015	8.7	0.44	0.28	12.0	6.76	3.06	0.27	.04	84.4	74.2	12.5	13.3
	27–30	6.56	0.11	.014	4.4	0.66	0.33	12.8	7.46	3.36	0.28	.07	87.4	79.4	8.8	11.8
BC1	30–40	6.65	0.21	.019	6.3	0.81	0.42	12.6	7.07	3.60	0.20	.07	86.3	86.8	4.1	9.1
BC2	40–52	6.12		.016										89.9	3.0	7.1
CB	52–60	6.50		.017										88.3	1.5	10.2
	60–72	6.45		.015										88.6	0.8	10.6
	72–84	6.54		.011										89.3	1.6	9.1

WHIPSAW SERIES

The Whipsaw soils are Orthic Eutric Brunisols of the Asp catena. The soils have dark Ah horizons. The brown sandy loam Bm overlies gravelly cobbly BC and C horizons.

Type location: Map sheet 92 H/SE, 49°28.7′ N 120°29.0′ W.

Range in characteristics: The solum is 8 to 12 inches thick. Gravel content increases from about 5% in the surface horizons to more than 50% in the C horizon. Ah horizons are 4 to 6 inches thick and dark gray to brown fine sandy loam to sandy loam. B horizons are 6 to 10 inches thick, dark brown sandy loam grading into gravelly loamy sand in the C horizons.

Similar series: Asp soils have an eluvial horizon and lack the Ah horizon of Whipsaw soils. Other Eutric Brunisols and Dark Gray soils have much thicker sola.

Landform and climate: Whipsaw soils occur on outwash terraces and deltas that are often kettled and hummocky. Elevations range from 2700 to 3500 feet. Parent materials are very coarse textured, neutral to slightly alkaline deposits. The climate is semiarid with a mean annual rainfall of 13 to 21 inches and mean annual temperatures of 38° to 42° F. The frost-free period is 75 to 90 days or more, and there are 1900 to more than 2150 growing degree-days over 42° F.

Associated soils: The main catenary member is the Asp soil. Whipsaw occurs with Tulameen, Thalia, and Alleyne soils.

Drainage and permeability: Rapidly drained with rapid to moderately rapid permeability.

Vegetation: Douglas-fir – Idaho fescue habitat type, characterized by an open forest of Douglas-fir and ponderosa pine with Idaho fescue, bluebunch wheat grass, silky lupine, and forbs in the ground cover.

Present use: Grazing and some crop production under irrigation.

Distribution and extent: Outwash terraces of the main valleys. Whipsaw occurs with Asp soils on about 6200 acres.

Remarks: The Whipsaw soil series was established in the Princeton map area in 1960.

Morphological description: Whipsaw series

Horizon	Depth inches	Color		Texture	Structure			Consistence	Coarse fragments %	Reaction class
		Dry	Moist		Grade	Size	Form			
L–F	0.25–0	needle and grass litter								
Ah	0–2	dark gray 10YR 4/1	black 10YR 2/1	fine sandy loam	moderate	coarse	granular	slightly hard	< 5	slightly acid
Bm1	2–6	brown 10YR 5/3	very dark grayish brown 10YR 3/2.5	fine sandy loam	moderate	coarse	granular	slightly hard	< 5	slightly acid
Bm2	6–10	brown 10YR 5/3	dark brown 10YR 4/3	fine sandy loam	moderate	coarse and fine	granular	slightly hard	< 5	slightly acid
BC	10–16	brown 10YR 5/3	dark brown 10YR 3/3	gravelly sandy loam	moderate	medium	subangular blocky	soft	> 30	slightly acid
IIC	16+	mixed colors		gravel			single grain	loose	> 50	slightly acid

Analyses: Whipsaw series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	C:N ratio	Fe	Al	Cation exchange, meq/100 g soil					Percent base saturation	Particle size distribution %			
								Capacity	Ca	Mg	K	Na		Sand	Silt	Clay	Fine clay
Ah	0–2	6.5	12.0	0.2	29.1	0.3	0.4	28.6	16.6	1.9	1.1	0.1	70.0	64.7	29.5	5.8	0.9
Bm1	2–6	6.4	2.9	0.1	24.1	0.3	0.2	12.1	8.6	1.5	0.4	0.1	87.3	64.6	30.3	5.1	1.5
Bm2	6–10	6.5	1.9	0.5	20.4	0.4	0.2	11.6	8.4	1.9	0.4	0.1	93.1	70.2	24.5	5.3	1.9
BC	10–16	6.4															
IIC	16+	6.5	0.6	0.2	15.7	0.5	0.2	6.2	5.0	1.3	0.1	0.1	100 +	93.1	6.2	0.7	0.8

WILBERT SERIES

The Wilbert soils are Degraded Dystric Brunisols of the Wilbert catena. The soils have L and F–H layers, thin indistinct Ae horizons, and pale brown sandy loam Bm horizons. These strongly acid horizons overlie gravelly C horizons that are medium acid in reaction.

Type location: Map sheet 92H/SE, 49°28.8′ N 120°8.8′ W.

Range in characteristics: The solum is 15 to 30 inches thick. Gravel is generally present and exceeds 30% in the C horizons. Bedrock may occur within 2 to 4 feet of the surface. The Ae horizon is light gray, fine sandy loam or loamy sand, about 0.5 inches thick. The brown to pale brown loamy sand B horizons grade into gravelly sandy loam colluvium. Compact till generally underlies the colluvium.

Similar series: Mazama, Nicomen, and Lawless soils differ in that the Mazama has Btj horizons, and the Nicomen and Lawless have podzolic B horizons.

Landform and climate: Wilbert soils occupy plateau ridges and slopes of low to moderate relief. Elevation ranges are from 4000 to 5500 feet. Parent materials are moderately coarse textured, slightly to medium acid till and colluvial deposits. Granodiorites, with argillites and basalts, underlie the soils and are the main components of the till and colluvium. The climate is continental, modified by maritime influences. The mean annual precipitation is 20 inches or more and the mean annual temperature is 38° F or less. The frost-free period is less than 50 days and there are 1200 to 1650 growing degree-days over 42° F.

Associated soils: Wilbert soils occur mainly with Bankeir and Pefferle soils.

Drainage and permeability: Well drained and moderately permeable.

Vegetation: Subalpine fir – red alpine blueberry habitat type, characterized by a dense forest of subalpine fir, Engelman spruce, Douglas-fir, and lodgepole pine and an understory of red alpine blueberry, twinflower, and arnica.

Present use: Logging; mainly spruce and Douglas-fir.

Distribution and extent: Upland plateau regions. Wilbert soils cover about 307,400 acres.

Remarks: The Wilbert soil series was established in the Princeton map area in 1960.

Morphological description: Wilbert series

Horizon	Depth inches	Color Dry	Color Moist	Texture	Structure Grade	Structure Size	Structure Form	Consistence	Coarse fragments %	Reaction class
L	1.25–0.25	litter of needles and moss								
F	0.25–0	partially decomposed needles	and moss							
Aej	0–0.25	gray 10YR 6/1	dark gray 10YR 4/1	loamy sand	weak	fine	granular	very friable	nil	strongly acid
Bm1	0.25–8	pale brown 10YR 6/3	dark yellowish brown 10YR 4/4	loamy sand	weak	medium	granular	very friable	10–15	medium acid
Bm2	8–15	pale brown 10YR 6/3	dark yellowish brown to brown 10YR 4/4 to 5/3	loamy sand	moderate	medium	granular	friable	10–15	medium acid
CB	15–25	white 2.5Y 8/2	light brownish gray 2.5Y 6/2	loamy sand	moderate	medium	subangular blocky	friable	10–15	medium acid
IIC	25+	weathered granitic rock								

Analyses: Wilbert series

Horizon	Depth inches	pH in H_2O	Organic matter %	Total N %	Fe	Al	Cation exchange, meq/100 g soil: Capacity	Ca	Mg	K	Na	Particle size distribution %: Sand	Silt	Clay
Bm1	0.25–8	5.57	2.17	0.07	0.75	0.81	7.40	1.65	0.34	0.28	0.09	70.57	26.50	2.93
Bm2	8–15	5.70	1.66	0.05	0.61	0.69	6.57	1.14	1.09	0.17	0.09	72.37	24.96	2.73
CB	15–25	5.72	0.16	0.01	0.85	0.15	3.79	2.51	0.77	0.13	0.09	71.77	25.27	2.96
IIC	25+	5.53	0.41	0.01	0.19	0.71	18.16	11.52	3.92	0.28	0.29			

PLANT COMMUNITIES AND SOILS

by

A. McLean and T. M. Lord

The vegetative zones of the area have been classified by the senior author (McLean 1969) as ponderosa pine, Douglas-fir, subalpine fir, mountain hemlock, and alpine. The chief plant communities of each zone are described and correlated with the soils.

Ponderosa Pine Zone (Ponderosa pine – bunch grass)

The ponderosa pine zone is found to a very limited extent at lower elevations in the drier parts of the Princeton basin and in valleys in the northern part of the area. Ponderosa pine occurs with bluebunch wheat grass, Idaho fescue, needle grasses, silky lupine, and pasture sage. Dark Gray Chernozemic soils are characteristic of this plant zone at elevations of 2400 to 3000 feet. The ponderosa pine zone is associated with soils of the Galena and Howarth map units at low elevations near Princeton village and in the Quilchena valley.

Douglas-fir Zone (Interior Douglas-fir)

The Douglas-fir zone is the most widely represented in the area and occurs between about 2800 and 4200 feet elevation. The most important and widespread plant community is Douglas-fir – pine grass, which is characterized by Douglas-fir, trembling aspen, lodgepole pine, ponderosa pine, pine grass, bearberry, arnica, and twinflower. Gray Luvisol soils dominate, with inclusions of Eutric Brunisols. The pine grass plant community forms the main vegetation within the Britton, Connaly, Alleyne, Tulameen, Midday, Asp, Trehearne, and Thalia map units.

On drier sites in the plant zone, at lower elevations, and on south-facing slopes, the Douglas-fir – Idaho fescue community occurs. This plant community has many species in common with the drier grasslands of the Tulameen and adjacent areas. Here, the soils belong mainly to the Dark Gray great group. Generally, correlation between the Idaho fescue community and the main soils of the Brenda, Howarth, and Galena units is good. Within the plant zone, the fescue–eriogonum community is associated with Black and Dark Gray Chernozemic soils and occurs intermittently. This community, which is dominated by Idaho fescue and bluebunch wheat grass, contains other herbs, such as silky lupine, tall white eriogonum, and Columbia needle grass. This grassland community is closely correlated with the soils of the Fairweather and Princeton map units.

Subalpine Fir Zone (Engelmann spruce – subalpine fir)

The subalpine fir zone begins at the upper limits of the Douglas-fir zone. This boundary generally occurs at elevations of about 4200 to 6600 feet. The subalpine fir zone can be divided into lower and upper parts. The most widespread plant community in the lower part is subalpine fir – pine grass, which occurs between 4200 and 5200 feet on drier sites. The present tree cover is mainly lodgepole pine, with Engelmann spruce and subalpine fir succession. Ground cover is dominated by red alpine blueberry, pine grass, and twinflower. The vegetation complex has strong affinities with the Douglas-fir zone and many species of the latter zone invade and persist after logging or fire. Brunisolic soils predominate. Most of the Henning soils occur under this community. Drier parts of the Mazama and Wilbert catenas are associated with pine grass vegetation.

The vegetation of the upper part of the zone, the subalpine fir – red alpine blueberry community, alternates on the landscape with that of the lower zone and extends up to about 5800 feet. The subalpine fir zone has been greatly disturbed by forest fires and logging in the past and most of the sites are in various stages of succession. The main tree species are subalpine fir, Engelmann spruce, lodgepole pine, and Douglas-fir, with a ground cover of red alpine blueberry, black mountain huckleberry, false-box, wintergreen, and arnica. Podzols, Brunisols, and Luvisols are represented by soils of the Lawless, Wilbert, Mazama, Eastmere, and Grant catenas. Within this community, on sites with an ample and continuous supply of moisture, the subalpine fir – bunchberry community is often found locally, usually at elevations near 5000 feet. The characteristic ground cover species are bunchberry, wintergreen, and twinflower. Soils associated with this community are mainly Gleyed Gray Luvisol and Gleyed Eutric Brunisols of the Grant, Mazama, and Wilbert catenas.

A false-heather phase of the subalpine fir – blueberry community occurs at elevations of about 5800 feet to 6800 feet. Under open stands of stunted spruce and subalpine fir with alpine larch and whitebark pine, the understory is dominated by red alpine blueberry, red and yellow false-heather, arnica, and valerian. Tree clumps alternate with open herbaceous areas near the tree line. The soils are Alpine Dystric Brunisols, Humo-Ferric Podzols, and Regosols. Soils of the Bonnevier map unit have developed under this vegetation.

Mountain Hemlock Zone

The mountain hemlock zone is found mainly in the plateau–mountain transitional zone along the western boundary of the area. The important trees are mountain hemlock, amabilis fir, and western red cedar, together with an understory of copperbush, blueberry, bunchberry, and

other forbs. False-heathers dominate at higher elevations. Humo-Ferric Podzols are the main soils within the Lawless and Pasayten map units.

Alpine Zone

No part of the area is in the true alpine zone, but climatic conditions on the high prominences of Thynne and Pennask mountains are much like those of alpine tundra. Vegetation is limited to dwarf shrubs, false-heathers, grasses, and forbs of the alpine communities. Much of the alpine tundra landscape consists of bare rock and icefields, with inclusions of Regosolic and Podzolic soils.

Other plant communities in the area are those on wetlands and Steeplands. Wetland plant communities are associated with river floodplains, seepage slopes, and wet depressions. The plant communities are generally unstable and variable. Soil units associated with this type of vegetation are Bluey, Iltcoola, Manning, Riddell, Coley, and Etches. Vegetation is sparse and variable on the Steeplands land type. Rock Outcrop has little or no vegetative cover.

METHODS OF SOIL ANALYSIS

The following methods were used to analyze the soil samples:

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pH (water). Method given in Atkinson, op. cit. p. 15.

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Easily soluble P. Bray method in Atkinson, op. cit. p. 25. 10:1 modified by M. John.

Cation-exchange capacity. Method given in Atkinson, op. cit. p. 29. NH_4Ac distillation—Ca, K, and Na by flame photometer; Ca + Mg by EDTA titration.

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GLOSSARY

acolian deposit Wind deposit, includes both loess and dunes. See **loess.**

alluvium A general term for all deposits of modern rivers and streams.

Animal–unit–month (AUM) The number of acres needed to graze one 1000-pound cow for one month.

base saturation percentage The extent to which the adsorption complex of a soil is saturated with exchangeable cations

other than hydrogen and aluminum. It is expressed as a percentage of the total cation-exchange capacity.

cation–exchange capacity The sum total of exchangeable cations that a soil can adsorb. It is sometimes called "total-exchange capacity," "base-exchange capacity," or "cation-adsorption capacity." It is expressed in millequivalents per grams of soil or of other adsorbing material, such as clay.

chroma The relative purity, strength, or saturation of a color; directly related to the dominance of the determining wavelength of the light and inversely related to grayness; one of the three variables of color. (See **Munsell color system, hue,** and **value, color.**)

clay films Oriented clay particles forming a coating on the surface of the soil aggregates and indicating translocated clay in the soil profile. Clay bridges are similar to clay films, but instead of forming coatings they form a latticework or bridges among the sand grains. They are found in medium and coarse textured soils.

coarse fragments Rock or mineral particles >2.0 mm in diameter.

coarse texture The texture exhibited by sands, loamy sands, and sandy loams, except very fine sandy loam. A soil containing large quantities of these textural classes.

cobblestone Rounded or partially rounded rock or mineral fragments 3 to 10 inches in diameter. See **coarse fragments.**

cobbly Containing large quantities of cobblestones.

colluvium A deposit of rock fragments and soil material accumulated at the base of steep slopes as a result of gravitational action.

color, soil See **Munsell color system.**

complex, soil See **soil complex.**

consistency (i) The resistance of a material to deformation or rupture. (ii) The degree of cohesion or adhesion of the soil mass. Terms used for describing consistency at various soil moisture contents are:
wet soil—nonsticky, slightly sticky, sticky, very sticky, nonplastic, slightly plastic, plastic, and very plastic.
moist soil—loose, very friable, friable, firm, very firm, and extremely firm.
dry soil—loose, soft, slightly hard, hard, very hard, and extremely hard.
cementation—weakly cemented, strongly cemented, and indurated.

delta A fan-shaped area formed by deposition of successive layers of debris brought down from the land and spread out on the bottom of a basin at the mouth of the river.

drumlin An elongated or oval hill of glacial drift, commonly glacial till, deposited by glacier ice with its long axis parallel to the direction of ice movement.

eluviation The removal of soil material in suspension or in solution from a layer or layers of soil.

esker A winding ridge of irregularly stratified sand, gravel, and cobbles laid down under the ice by a rapidly flowing glacial stream.

fan A fan-shaped deposit of outwash at the toe of a slope where a tributary valley enters a main valley.

fine texture Consisting of or containing large quantities of the fine fractions, particularly of silt and clay. Includes all clay loams and clays: clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay, and clay textural classes. It is sometimes subdivided into clayey texture and moderately fine texture. See **soil texture.**

fluvioglacial See **glaciofluvial deposits.**

frost-free period The average number of days between the last spring temperature of 32° F and the first fall temperature of 32° F.

glacial drift All rock material transported by glacier ice, glacial meltwater, and rafted by icebergs. This term includes till, stratified drift, and scattered rock fragments.

glacial till Unsorted and unstratified materials deposited by glacial ice.

glaciofluvial deposits Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces. See **glacial drift** and **glacial till.**

gleysation A soil forming process, operative under poor drainage, that results in reduction of iron and other elements and in gray colors and mottles.

great group The fifth category (V) in the Canadian system of soil classification. It is a taxonomic group of soils having certain morphological features in common that reflect a similar pedogenic environment. Examples are Black, Podzol, Gray Luvisol, Brown Wooded, Regosol, Humic Gleysol.

ground moraine Generally an unsorted mixture of rocks, boulders, sand, silt, and clay deposited by glacial ice. The predominant material is till, though stratified drift is present in places. The till is thought to have accumulated largely by lodgment beneath the ice, but partly also by being let down from the upper surface of the ice through the ablation process. Ground moraine is most commonly in the form of undulating plains with gently sloping swells, sags, and enclosed depressions.

growing degree-days The number of cumulative degrees above 42° F during the growing season.

horizon See **soil horizon.**

hue One of the three variables of color. It is caused by light of certain wavelengths and changes with the wavelength. See **Munsell color system, chroma** and **value, color.**

illuviation The process of deposition of soil material removed from one horizon to another in the soil; usually from an upper to a lower horizon in the soil profile. Illuviated substances include silicate clay, iron, and aluminum hydrous oxides and/or organic matter.

kame An irregular ridge or hill of stratified glacial drift.

kettle A closed depression created by the melting of buried or partly buried blocks of ice after sedimentation has ceased.

lacustrine deposit Material deposited in lakewater and later exposed either by lowering the water level or by uplift of the land. These sediments range in texture from sands to clays.

land type See **miscellaneous land type.**

leaching The removal of materials in solution from the soil.

loess Material transported and deposited by wind and consisting mainly of silt-sized particles.

mean annual increment (MAI) The total yield of a stand divided by the age of a stand.

medium texture Intermediate between fine textured and coarse textured soils. It includes the following textural classes: very fine sandy loam, loam, silt loam, and silt.

miscellaneous land type (land type) A mapping unit for areas of land that have little or no natural soil, that are almost

inaccessible for orderly examination, or where, for any reason, it is not feasible to classify the soil; for example, rough mountainous land, eroded slopes, and marshes.

moderately coarse texture Consisting mainly of coarse particles. In soil textural classification, it includes all the sandy loams except very fine sandy loam. See **coarse texture.**

moderately fine texture Consisting mainly of intermediate-size soil particles or with relatively small amounts of fine or coarse particles. In soil textural classifications, it includes clay loam, sandy clay loam, and silty clay loam. See **fine texture.**

moraine See **ground moraine.**

mottles Spots or blotches of different colors or shades of color interspersed with the dominant color.

Munsell color system A color designation system that specifies the relative degrees of the three simple variables of color: hue, value, and chroma. For example: 10YR 6/4 is a color (of soil) with hue 10YR, value 6, and chroma 4. These notations can be translated into several different systems of color names as desired. See **chroma, hue,** and **value, color.**

order, soil The highest category (VI) in the Canadian soil classification system. All the soils of Canada are divided into eight orders: Chernozemic, Solonetzic, Luvisolic, Podzolic, Brunisolic, Regosolic, Gleysolic, and Organic. All of the soils within an order have one or more basic characteristics in common.

outwash Sediments "washed out" by flowing water beyond the glacier and laid down in thin foreset beds as stratified drift. Particle size may range from boulders to silt.

parent material The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of a soil is developed by pedogenic processes.

peat Unconsolidated soil material consisting largely of undecomposed, or only slightly decomposed, organic matter.

permeability, soil (i) The ease with which gases, liquids, or plant roots penetrate or pass through a bulk mass of soil or a layer of soil. Since different soil horizons vary in permeability, the particular horizon under question should be designated. (ii) The property of a porous medium itself that relates to the ease with which gases, liquids, or other substances can pass through it.

pH, soil The negative logarithm of the hydrogen-ion activity of a soil. The degree of acidity (or alkalinity) of a soil as determined by means of a glass, quinhydrone, or other suitable electrode or indicator at a specified moisture content or soil–liquid ratio, and expressed in terms of the pH scale.

phase, soil A subdivision of a soil type or other unit of classification having characteristics that affect the use and management of the soil, but which do not vary sufficiently to differentiate it as a separate type. A variation in a property or characteristic, such as degree of slope, degree of erosion, or content of stones.

soil complex A mapping unit used in detailed and reconnaissance soil surveys where two or more defined soil units are so intimately intermixed geographically that it is impractical, because of the scale used, to separate them.

soil horizon A layer of soil or soil material approximately parallel to the land surface that differs from adjacent genetically related layers in properties such as color, structure, texture, consistency, chemical, biological, and mineralogical composition.

The following is a list of the designations and some of the properties of soil horizons. More detailed definitions of some horizons may be found in the *System of Soil Classification for Canada,* 1970.

Organic horizons contain more than 30% organic matter. Three horizons are recognized.

L—The original structures of the organic material are easily discernible.

F—The accumulated organic material is partly decomposed.

H—The original structures of the organic material are undiscernible.

Master mineral horizons and layers contain less than 30% organic matter.

A—A mineral horizon formed at or near the surface in the zone of removal of materials in solution and suspension or maximum in situ accumulation of organic matter, or both.

B—A mineral horizon characterized by one or more of the following:

- An enrichment in silicate clay, iron, aluminum, or humus.
- A prismatic or columnar structure that exhibits pronounced coatings or stainings associated with significant amounts of exchangeable sodium.
- An alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both.

C—A mineral horizon comparatively unaffected by the pedogenic processes operative in A and B, except gleying, and the accumulation of carbonates and more soluble salts.

R—Underlying consolidated bedrock.

Roman numerals are prefixed to horizon designations to indicate unconsolidated lithologic discontinuities in the profile. Roman numeral I is understood for the uppermost material and therefore is not written. Subsequent contrasting materials are numbered consecutively in the order in which they are encountered downward, that is, II, III, and so on.

Lowercase suffixes

b—Buried soil horizon.

c—A cemented (irreversible) pedogenic horizon.

ca—A horizon of secondary carbonate enrichment where the concentration of lime exceeds that in the unenriched parent material.

cc—Cemented (irreversible) pedogenic concretions.

e—A horizon characterized by removal of clay, iron, aluminum, or organic matter alone or in combination. Higher in color value by one or more units when dry than an underlying B horizon. It is used with A, (Ae).

f—A horizon enriched with hydrated iron. It usually has a chroma of 3 or more. The criteria for an f horizon (except Bgf) are: the oxalate-extractable Fe+Al exceeds that of the IC horizon by 0.8% or more, and the organic matter to oxalate-extractable Fe ratio is less than 20. These horizons are differentiated on the basis of organic matter content into:

Bf—less than 5% organic matter.

Bfh—5 to 10% organic matter.

Bhf—more than 10% organic matter.

g—A horizon characterized by gray or prominent mottling or both, indicative of permanent or periodic intense reduction, for example Aeg, Btg, Bg, and Cg.

gf—(used with B)—The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more and the dithionite-extractable Al does not exceed that of the IC by more than 0.5%.

h—A horizon enriched with organic matter.

Ah—An A horizon of organic matter accumulation. It contains less than 30% organic matter. It is one Munsell unit of color value darker than the layer immediately below, or it has at least 1% more organic matter than the IC, or both.

Ahe—This horizon has been degraded as evidenced by streaks and splotches of light and dark gray material and often by platy structure.

Bh—This horizon contains more than 2% organic matter and the organic matter to oxalate-extractable Fe ratio is 20 or more.

j—This is used as a modifier of suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. For example, Aej—an eluvial horizon that is thin, discontinuous, or faintly discernible.

k—Presence of carbonate.

m—A horizon slightly altered by hydrolysis, oxidation, or solution or all of these to give a change in color or structure, or both.

n—A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less.

p—A layer disturbed by man's activities. Ap.

s—A horizon containing detectable soluble salts.

sa—A horizon of secondary enrichment of salts more soluble than Ca and Mg carbonates where the concentration of salts exceeds that present in the unenriched parent material.

t—A horizon enriched with silicate clay as indicated by a higher clay content (by specified amounts) than the overlying eluvial horizon, a thickness of at least 5 cm, oriented clay in some pores or on ped surfaces, or both, and usually a high ratio of fine (0.2 micron) to total clay than the IC horizon.

soil reaction See **reaction, soil** and **pH, soil.**

soil structure The aggregation of primary soil particles into compound particles, which are separated from adjoining aggregates by surfaces of weakness. Aggregates differ in grade (distinctness) of development. Grade is described as structureless (no observable aggregation or no definite orderly arrangement, but amorphous if coherent or single grained if noncoherent), weak, moderate, and strong. The aggregates vary in class (size) and are described as fine, medium, coarse, or very coarse. The size classes vary according to the type (shape) of structure. The types of structure mentioned in the report are:

granular—having more or less rounded aggregates without smooth faces and edges, relatively nonporous.

platy—having thin, platelike aggregates with faces mostly horizontal.

prismatic—having vertical prisms with well-defined faces and angular edges.

blocky—having blocklike aggregates with sharp, angular corners.

subangular blocky—having blocklike aggregates with rounded and flattened faces and rounded corners.

An aggregate is described in the order of grade, class, and type. Two examples of this convention are: strong, medium blocky; moderate, coarse granular.

soil texture The percentages of sand, silt, and clay in a soil determine its texture. Size groups from 2 mm to 0.05 mm in diameter are called sand, those from 0.05 to 0.002 mm are called silt, and those less than 0.002 mm in diameter are called clay. Sands are coarse textured, loams are medium textured, and clays are fine textured.

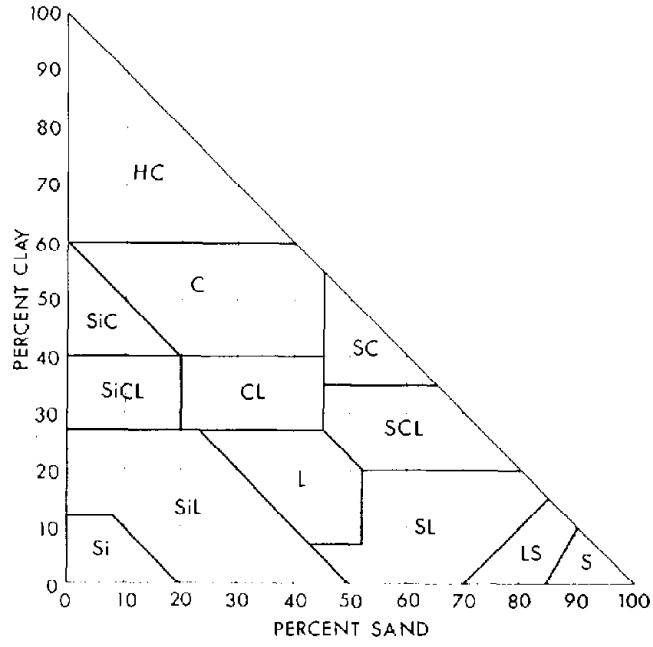

Figure 18. Percentage of clay and sand in the main textural classes of soils; the remainder of each class is silt. The limits between classes are as in Soil Survey Manual, USDA Handbook 18, 1951.

solum (plural **sola**) The upper horizons of a soil in which the parent material has been modified and within which most plant roots are confined. It consists usually of A and B horizons.

subgroup, soil The fourth category (IV) in the Canadian soil classification system. These soils are subdivisions of the great groups, therefore each soil is defined more specifically.

talus Fragments of rock and other soil material accumulated by gravity at the foot of cliffs or steep slopes.

till (i) Unstratified glacial drift deposited directly by the ice and consisting of clay, sand, gravel, and boulders intermingled in any proportion. (ii) To plow and prepare for seeding, to seed or cultivate the soil.

value, color The relative lightness of intensity of color and approximately a function of the square root of the total amount of light. One of the three variables of color. (See **Munsell color system, hue,** and **chroma.**)

varve A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one a thick light-colored layer of silt and fine sand laid down in the spring and summer, and the other a thin, dark-colored layer of clay laid down in the fall and winter. Since low temperatures are important in delaying the settling of the clay particles, it is assumed that varve formation can occur only with glacial waters. The salts of seawater prevent the formation of varves of this kind. The electrolytes in seawater cause flocculation, resulting in a homogeneous mass.

PLANT LIST

Common names	*Botanical names*
alpine larch	*Larix lyallii* Parl.
amabilis fir	*Abies amabilis* (Dougl.) Forb.
balsamroot	*Balsamorhiza sagittata* (Pursh) Nutt.
beaked sedge	*Carex rostrata* Stokes
bearberry (kinnikinnick)	*Arctostaphylos uva-ursi* (L.) Spreng.
bitter cherry	*Prunus emarginata* Dougl.
black cottonwood	*Populus trichocarpa* Torr. & Gray
black mountain huckleberry	*Vaccinium membranaceum* Dougl. ex Hook.
bluebunch wheat grass	*Agropyron spicatum* (Pursh) Scrib. & Sm.
buffaloberry (soopolallie)	*Shepherdia canadensis* (L.) Nutt.
bunchberry	*Cornus canadensis* L.
bunch grass	*Andropogon scoparius* Michx.
copperbush	*Cladothamnus pyrolaeflorus* Bong.
Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco
Engelmann spruce	*Picea engelmannii* Parry
false-box	*Pachystima myrsinites* (Pursh) Raf
fescue	*Festuca* spp.
flat-top spirea	*Spiraea betulifolia* Pall.
fleabane	*Erigeron* spp.
heartleaf arnica	*Arnica cordifolia* Hook.
Idaho fescue	*Festuca idahoensis* Elmer
Kentucky blue grass	*Poa pratensis* L.
lodgepole pine	*Pinus contorta* Dougl.
moss-heathers	*Cassiope* spp.
mountain hemlock	*Tsuga mertensiana* (Bong.) Carr.
mountain valerian	*Valeriana sitchensis* Bong.
needle grasses	*Stipa* spp.
pasture sage (fringed sage)	*Artemisia frigida* Willd.
pine grass	*Calamagrostis rubescens* Buckl.
ponderosa pine	*Pinus ponderosa* Laws.
rabbitbush	*Chrysothamnus nauseosus* (Pall.) Britt.
red alpine blueberry	*Vaccinium scoparium* Leiberg.
red false-heather	*Phyllodoce empetriformis* (Sw.) D. Don
red-osier dogwood	*Cornus stolonifera* Michx.
redtop	*Agrostis alba* L.
reed grass (bluejoint)	*Calamagrostis canadensis* (Michx.(Beauv.
saltgrass	*Distichlis* spp.
saskatoon	*Amelanchier alnifolia* Nutt.
silky lupine	*Lupinus sericeus* Pursh
snowbush	*Ceanothus velutinus* Dougl.
subalpine fir	*Abies lasiocarpa* (Hook.) Nutt.
tall manna grass	*Glyceria grandis* Wats.
tall white eriogonum	*Eriogonum heracleoides* Nutt.
trembling aspen	*Populus tremuloides* Michx.
twinflower	*Linnaea borealis* L.
western red cedar	*Thuja plicata* Donn
western white pine	*Pinus monticola* Dougl.
whitebark pine	*Pinus albicaulis* Engelm.
willows	*Salix* spp.
wintergreen	*Pyrola secunda* L.
yellow false-heather	*Phyllodoce glanduliflora* (Hook.) Coville