SOILS

of the

Upper Part of the Fraser Valley

in the

ROCKY MOUNTAIN TRENCH
of
BRITISH COLUMBIA

H. J. HORTIE, A. J. GREEN, and T. M. LORD
Canada Department of Agriculture

Report No. 10
of the
British Columbia Soil Survey

RESEARCH BRANCH
CANADA DEPARTMENT OF AGRICULTURE
in cooperation with the
RESEARCH DIVISION
B.C. FOREST SERVICE
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*Present address: Department of Agriculture, Charlottetown, P.E.I.

The Queen's Printer for Canada
Ottawa, 1970
Cat. No. A57-420

ACKNOWLEDGMENTS

The authors of this report wish to acknowledge their appreciation for assistance from the following people.

Dr. A. Leahey, former Research Coordinator (Pedology), Canada Department of Agriculture; Mr. J. H. Day, Soil Research Institute, Ottawa; and Mr. L. Farstad, Head, Pedology Section, Research Station, Vancouver, inspected the field work and reviewed the manuscript.

Mr. W. Arlidge, Forester, Research Division, B.C. Forest Service, wrote the forestry and vegetation section and ably assisted the field parties.

Messrs. V. Case and St. Claire Forde assisted in the field survey. Mr. H. Cook, Aleza Lake, was boatman and guide on the Fraser River and its tributaries.

The British Columbia Department of Lands and Forests, Victoria, supplied the aerial photograph for Fig. 1 and the Department of Recreation and Conservation, Victoria, supplied the photograph for Fig. 3. The Department of Energy, Mines, and Resources, Ottawa, supplied the base maps and printed the soil map. The Cartography Section of the Soil Research Institute prepared the soil map and Fig. 2 and 4.

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SUMMARY

This is a report of a reconnaissance soil survey of the upper part of the Fraser Valley. The purpose of the survey was to map and classify the soils in the area and to use the information as a basis for making interpretations for agriculture.

The area described in the report covers mainly the floor of the Rocky Mountain Trench and the eastern part of the Fraser Basin. The main physiographic divisions are: (i) level to undulating areas of alluvium and lacustrine deposits bordering the Fraser River; (ii) undulating and rolling areas of glacial till, glacial outwash plains, and terrace; and (iii) mountainous areas bordering the trench.

The climate of the area is characterized by cold winters, short cool summers, and light to moderate precipitation.

The surveyed area is totally forested. A montane forest consisting of spruces and alpine fir characterizes the western part, and western hemlock, western red cedar, and Douglas fir are common in the eastern part.

Twenty soil series, two soil complexes, and one land type were established; these are the basis for the map units shown on the map, which has a scale of 1 inch equals 2 miles.

The soils on the glacial till and outwash uplands are dominantly well-drained members of the Podzol and Gray Wooded great groups, whereas the soils of the lacustrine and alluvial basins are mainly imperfectly drained members.

Productivity of the soil varies with texture, topography, drainage, and degree of podzolization.

Approximately 7,500 acres have been improved for the production of grasses and forage crops. Sheep and beef cattle production is of some importance in this area.

The soils within the 956,150 acres surveyed were classified according to their productivity, adaptability, and limitations for agriculture by interpretation of the soil survey data. They belong in Capability Classes 2, 3, 4, 5, and 7. Classes 2 to 4 are capable of sustained use for cultivated crops; Class 5 is only suitable for perennial forage crops; and Class 7 is suitable for forestry, wildlife, and recreation.

Most of the soils are in Classes 5 and 7. Climatic restrictions eliminate Class 1; Class 2 soils are very limited in extent. Organic soils are not included in this capability classification.

Less than 18% of the area mapped in the upper part of the Fraser Valley is suitable for sustained arable agriculture.

PREFACE

This report describes the soil resources of the upper part of the Fraser Valley of British Columbia. As a soil survey publication, it describes the soils of the area; included is information and data describing climate, vegetation, soil parent materials, and other factors affecting the use of soils.

The continued development of the forest products industry and the future of agriculture within the area depend on proper management and use of the soils. The information contained in this report is intended to aid in the proper utilization of these soils.

GENERAL DESCRIPTION OF THE AREA

Location and Extent

The surveyed area of the Fraser Valley lies in the central part of the Rocky Mountain Trench (Fig. 1). From Valemount, the narrow steep-walled trench follows a direct line northwest for 160 miles to open out and merge with the Nechako Plateau near Hansard. The area is bounded on the northwest by the meridian 122°30′N, and the Fraser River and terminates in the southeast in the upper valleys of the Fraser, Canoe, and Albreda rivers. The area surveyed covers 956,150 acres.

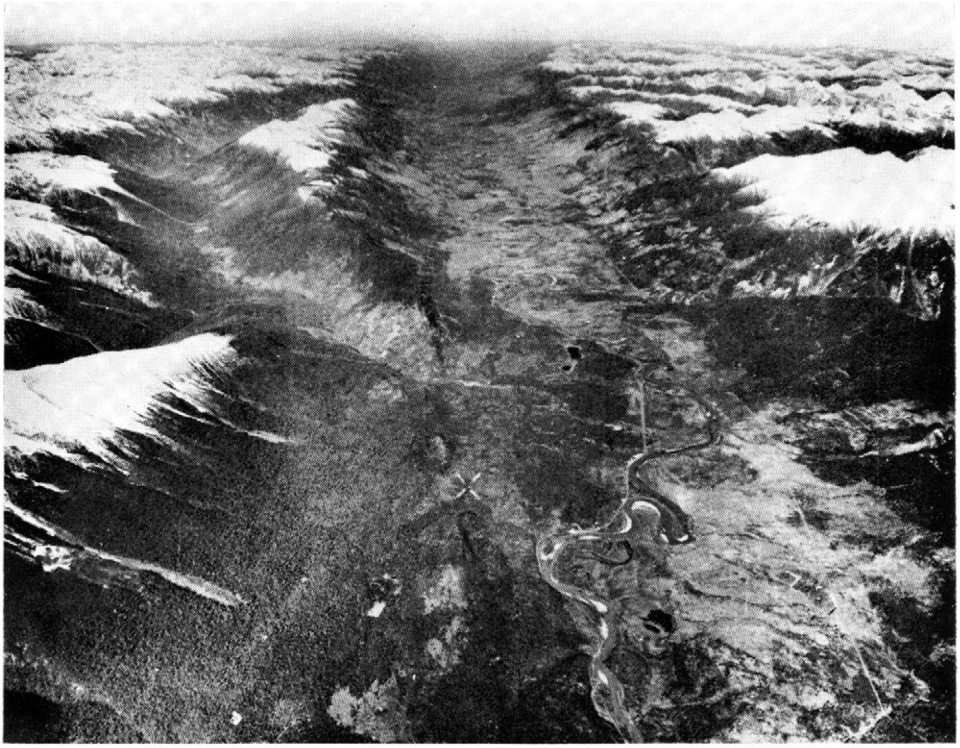


Fig. 1. View of Rocky Mountain Trench looking northwestward from Tête Jaune.

History and Development

Fur traders carried out the early exploration in the area. The North-West Company was established at Fort George in 1807 to administer the fur trade. After the decline of the fur trade, a great influx of prospectors and miners seeking placer gold passed through the area between 1862 and 1872.

In 1906 the Grand Trunk Pacific Railway, since incorporated into the Canadian National Railways, started construction of a railway from Edmonton. This railway was completed to Prince Rupert on the Pacific Coast in 1914. When the anticipated land development in the McBride – Tête Jaune Cache area failed to materialize, many of the settlers turned to logging, prospecting, or trapping. The lack of markets and suitable cash crops remained major problems until World War II. The war brought new demands for lumber and with increasing prosperity and new markets, the area began to develop. The lumber industry has established itself on a permanent basis and should continue to be the major factor in the economic stability of the area.

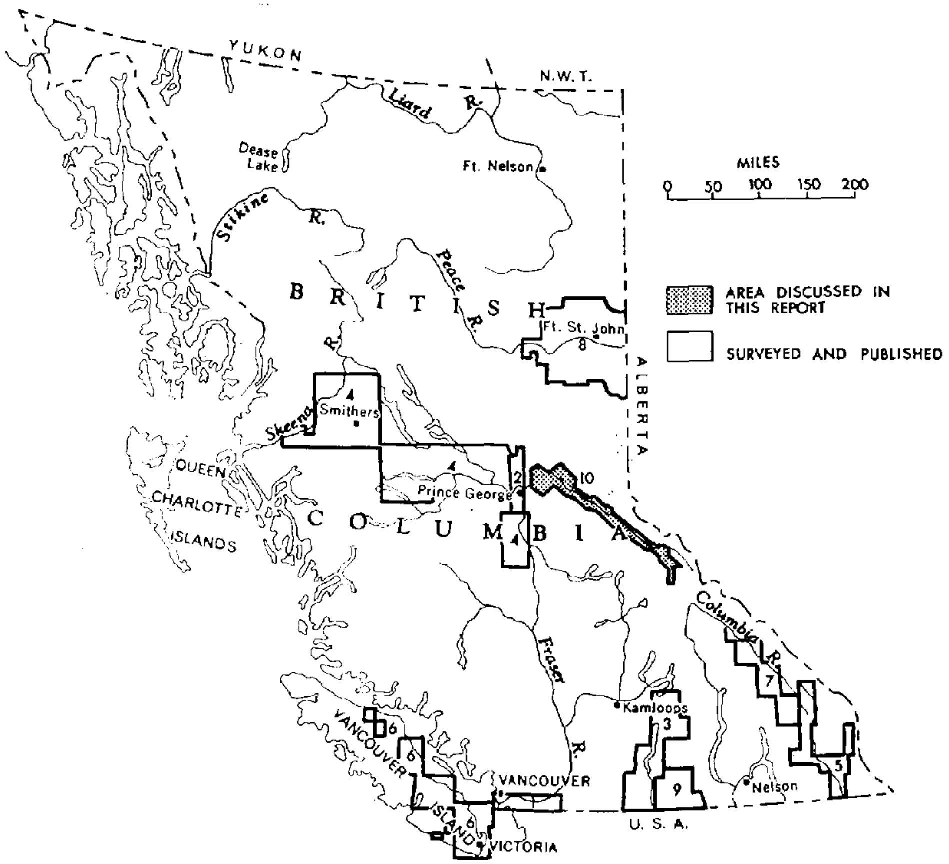


Fig. 2. Map of British Columbia showing location of the surveyed area, and of areas in British Columbia for which soil survey reports and maps have been published. 1. Lower Fraser Valley. 2. Prince George Area. 3. Okanagan and Similkameen valleys. 4. Quesnel, Nechako, Francois Lake, and Bulkley-Terrace areas. 5. Upper Kootenay and Elk valleys. 6. Southeast Vancouver Island and Gulf Islands. 7. Upper Columbia Valley. 8. Peace River Area. 9. Kettle Valley.

Population, Industries, and Communications

The upper part of the Fraser Valley has a population of approximately 5,100 persons. The population is scattered in small lumbering communities along the Canadian National Railways line.

The main center for the western part of the map area is Prince George, serving the communities of Willow River, Giscome, Aleza Lake, Hansard, and Sinclair Mills, by road and rail. The southeastern part of the map area is served by the village of McBride, population 590, and the village municipality of Valemount, population 631.

Logging and lumbering are the main industries, and there is some farming particularly in the McBride district. Trapping provides winter employment for some of the residents. The mountains in the area have been prospected, but there are no producing mines at the present time. Most of the rivers entering the Fraser in this area and the Fraser itself have been assessed for potential power development.

At the present time nearly all roads are dirt or gravel surfaced. With the paving of the existing highway between Kamloops and McBride in 1969 and the completion of the Northern Trans Provincial Highway linking McBride to Prince George in 1970, it is expected that the use of the recreational attractions of the area will expand greatly. Mail, telegraph, and telephones services operate throughout the valley.

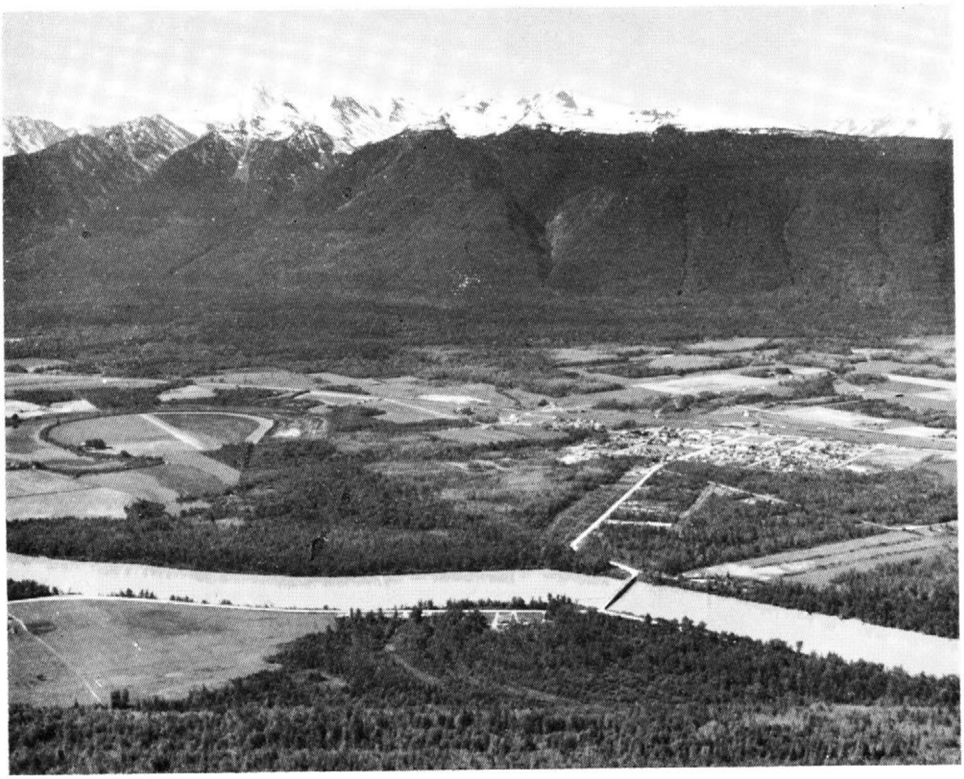


Fig. 3. View looking west across the Fraser River at McBride. The town is on proglacial lacustrine sediments. The oxbow lake at the left is in alluvium. Above the lacustrine deposits there are till and colluvial deposits adjacent to the valley wall.

Agriculture and Forestry

The earliest recorded information for the area indicates that forest and agricultural development occurred following the construction of the Grand Trunk Pacific Railway between Edmonton and Prince Rupert in 1914. Between 1912 and 1918, settlement commenced at McBride, Penny, Hansard, Giscome, Croydon, and Dunster. The local resources of these points are described as lumbering and farming. Generally, mixed farming accompanied lumbering, and supplied farm products for the population engaged in lumbering.

The trend established in the early development of the area's resources has not significantly changed in recent years. The area of farm land is 25,510 acres (2), of which 7,498 acres are improved land. There are 97 farms in the area and a total farm population of 525. Forage crops, coarse grains, potatoes, and clover seed are produced on the 5,173 acres of land under crops. Pasture accounts for 1,818 acres of improved land. There is some dairying, ranching, and sheep and hog raising. Less than 10% of the farms are managed as full-time operations. The balance of the operators supplement their farm income by working in the forest industry or other occupations.

During the same period, the development of forest resources has grown into a major provincial and national industry. Most of the area is now regulated and operated under Tree Farm Licenses, Public Working Circles, and Sustained Yields Units. The estimated yields for timber are given below.

Estimated Merchantable Volume
(Volume of trees 12 inches d.b.h. and over)

Tree Farm Licenses	178,450 M ft^3
Public Working Circles and Sustained Yield Units	490,750 M ft^3
Unregulated	38,800 M ft^3
Total	700,000 M ft^3

*Estimated Annual Sustained Yield**

Tree Farm Licenses	2,135 M ft^3
Public Working Circles, Sustained Yield Units, and Unregulated	9,865 M ft^3
Total	12,000 M ft^3

Assuming complete sustained use, the estimated value of lumber from the forest crop in 1960 was valued at $36,570,000. Although it may be some time before sustained use of the forest crop is attained in the surveyed area, the above yields and values indicate the tremendous potential of the forest products industry.

Physiography

Two distinct physiographic divisions of British Columbia are represented in the upper part of the Fraser Valley (Fig. 5). They are the Rocky Mountain Trench and the Fraser Basin, a subdivision of the Interior Plateau (4).

The Rocky Mountain Trench is a great troughlike valley forming the western boundary of the Rocky Mountains in eastern British Columbia. Beginning just south of the international boundary, the trench extends northwest for more than 900 miles.

The central part, carrying the Fraser River, is bounded on the west by the Columbia Mountains. From Tête Jaune to Grand Canyon, the floor of the trench lies between 2,000 and 3,000 ft above the sea and varies in width from 2 to 4 miles. At Grand Canyon, the trench opens into the Fraser Basin, an eastern subdivision of the Interior Plateau.

The Fraser Basin may be described as a rolling till plain containing frequent glacial lake basins. Relief is limited to a few hundred feet. Occasional rock knolls pierce the surface of the plain. They are most noticeable in the Nechako Plain, to the north and south of Eaglet Lake. The main rivers have cut channels into the plain; some channels are 400 ft deep on bedrock.

The dominant topographic feature of the northern part of the area is a large preglacial channel that extends in an easterly direction from Willow River to Hansard. The channel is now occupied by a series of lakes, swamps, and streams.

Drainage

The Fraser River dominates the drainage of the classified area. Rising near the British Columbia – Alberta boundary in the Rocky Mountains, the Fraser enters the trench at Tête Jaune. Here a major tributary flowing from the southeast, the

*Data supplied by Research Division, B.C. Forest Service, Victoria, B.C.

McLennan River, joins the Fraser River. The headwaters of the McLennan River are separated by only a few miles from those of two main drainage systems, the Columbia and the North Thompson. The Canoe River rises in the Columbia Mountains, flows across the trench at the base of Canoe Mountain, and then southeastward to join the Columbia River about 55 miles downstream. Near the community of Albreda, Albreda Creek rises within 2 miles of the Columbia drainage and flows southward to meet the North Thompson River.

Leaving Tête Jaune, the Fraser flows northwestward in the Trench. Major tributaries entering the Trench from the Rocky and Columbia mountains between Tête Jaune and the Grand Canyon are: Raush, Castle, Holmes, Doré, McKale, Goat, Morkill, Dome, Slim, and Torpy rivers. Where the Trench broadens out to merge with the Plateau, two large rivers, the Bowron and the Willow, which drain the northern part of the Columbia Range, enter the Fraser.

The McGregor River, rising in the Rocky Mountains on the British Columbia – Alberta border, empties into the Fraser about 10 miles northwest of Hansard. From its mouth to a point 18 miles upstream a pitted delta covers about 60 sq miles. Much of the alluvium along the river channels is poorly drained and subject to flooding during spring runoff.

A number of fairly large lakes and many small lakes, ponds, and swamps occupy the depressions and kettles of the McGregor outwash. The only large lakes within the surveyed area, Eaglet Lake and Hansard Lake, are connected by marshy stream channels and sloughs lying in the preglacial channel between the villages of Willow River and Upper Fraser.

Climate

The climate of the surveyed area is characterized by cold winters, short, cool summers, and light to moderate precipitation. This climatic type has been described as Humid Continental (3).

Data from the meteoroligical stations at McBride, Dome Creek (inactive), Aleza Lake, and Prince George are presented in Tables 1, 2, and 3. The Prince George station is located west of the surveyed area. A summary of the climate of the area is given in Table 1.

The average yearly precipitation is 35.9 inches at Aleza Lake, 29.8 inches at Dome Creek, and 21.3 inches at McBride (Table 1). One third to one half of the precipitation falls as snow.

The general pattern of precipitation throughout the area is similar, but the total amounts differ. The rainfall varies widely from year to year and from month to month. It is low until May and then it gradually increases to the end of June. It decreases during the first 2 weeks of July and then rises to a second peak in early August. This is followed by another low during late August and early September (7).

The mean monthly temperature (Table 2) remains below freezing from November until March at all stations. January is the coldest month with the lowest mean monthly temperature recorded at Aleza Lake. July and August are the warmest months with a mean monthly temperature of approximately 60F. Average temperatures are slightly higher in the growing season at McBride and Dome Creek than at other locations.

A more accurate method of comparing temperatures in different areas is the "growing degree-day" or "heat unit." The number of heat units in a day is the number of degrees that the mean temperature is above 42F.

The general pattern of heat units is similar at all locations (3). Only 15% of the total heat units for the growing season can be expected before May 31. Half the total is received in June and July, 20% in August, and 15% in September. The records emphasize the need for cool-climate crops (7).

McBride has a frost-free period of 82 days, whereas Prince George has 72 days (Table 3). Frost (32F) may occur in any month during the growing season. Such frosts cause little damage to field crops recommended for central British Columbia.

The effect of climate on farm operations in the area is shown in Table 4 and Figure 4. Climatic data together with the type of farm work done each season are used to calculate working days, that is, days when farm operations can be carried out successfully on a clay soil. In the Central Interior of British Columbia winter moisture seldom permits any tillage during April. Spring tillage and seeding are the main operations from May 1 until June 20, haying continues until July 31, and the grain harvest is the main operation for the rest of the season. A comparison of working days at Prince George and McBride is shown in Figure 4.

Low evaporation, resulting from shorter days and lower temperatures plus heavy night dews, decreases the number of working days after September.

Table 1. The Climate at Locations in or near the Surveyed Area

Location	Years observed	Altitude	Precipitation (inches)		Heat units[1]	Mean temperature (F)	
			April-Aug.	Annual	April-Aug.	April-Aug.	Annual
Prince George[2]	20	2,218	10.32	24.67	1,597	52.0	38.0
Aleza Lake[3]	13	2,050	11.07	35.87	1,660	51.6	37.0
Dome Creek[3]	32	2,200	11.35	29.83	1,857	54.0	39.8
McBride[2]	40	2,360	7.74	21.31	1,799	53.7	40.0

[1]The number of day-degrees above 42°F.

[2]Temperature and percipitation tables for British Columbia 1967. Can. Dep. Transport, Meteorological Branch, Toronto.

[3]Climate of British Columbia report for 1962. B.C. Dep. Agr., Victoria, B.C.

Table 2. Mean Monthly and Annual Temperatures (F) at Stations in or near the Surveyed Area[1]

	Prince George[1]	Aleza Lake[2]	Dome Creek[1]	McBride[1]
Years observed	18	10	32	30
January	11.6	9	15.4	16.0
February	18.5	19	20.4	22.0
March	27.8	27	30.5	30.2
April	39.7	37	41.7	42.6
May	49.4	49	50.8	51.1
June	55.2	56	57.2	56.3
July	58.9	60	61.1	60.5
August	56.6	57	59.3	58.0
September	50.2	50	51.7	51.3
October	40.7	40	41.7	42.0
November	27.5	27	28.5	28.9
December	20.1	19	19.0	21.2
Year	38.0	37	39.8	40.0

[1]Climate of British Columbia report for 1962. B.C. Dep. Agr., Victoria, B C.

[2]Temperature and precipitation tables for British Columbia 1967. Can. Dep. Transport, Meteorological Branch, Toronto.

Table 3. Average Dates of Spring and Fall Frosts, 1942 – 60 (7)

	Frost (32F)			Killing frost (28F)		
Location	Frost-free days	Last spring frost	First fall frost	Frost-free days	Last spring frost	First fall frost
Prince George	72	June 14	Aug. 25	119	May 19	Sept. 15
McBride	82	June 10	Aug. 31	122	May 19	Sept. 18

Table 4. Rainfall and Number of Working Days; Seasonal Average for 1941 – 60 (7)

	McBride	Prince George
	Rainfall (inches)	
Spring	3.30	4.25
Summer	2.61	3.21
Fall	3.91	4.97
Total	9.82	12.43
	Working days	
Spring	62.7	55.5
Summer	23.9	18.0
Fall	30.9	26.5
Total	117.5	100.0

Native Forests and Vegetation

by *J. W. C. Arlidge*

The surveyed area is totally forested. Rowe (9) classifies the part west of Sinclair Mills as the Montane Transition Section and the part east of Sinclair Mills as the Northern Aspen Section of the Montane Forest Region.

The forests of the Montane Transition Section are composed of a mixture of spruces (white spruce, Engelmann spruce, and their intergrades) and alpine fir with scattered white birch, occasional trembling aspen, and Douglas fir. Stumps and rotting trunks of Douglas fir suggest that this species had a greater representation in the recent past. Lodgepole pine occurs in pure stands and in varying mixtures with spruce and other species following fires. Aspen and birch also form pure stands or sands mixed with other species following fires. Black spruce and lodgepole pine, together or separately, are found in bogs. Black cottonwood is found on alluvial bottom soils (Fig. 6). Sporadic occurrences of western hemlock and western red cedar in the easterly part of the area indicate transition to the Northern Aspen Section.

The forests of the Northern Aspen Section are characteristically composed of western hemlock, western red cedar, and Douglas fir, mixed with spruce and alpine fir. Spruce and alpine fir grow with black cottonwood and occasional cedar on the lowland alluvium and accompany cedar on wet slopes with seepage water at or near the surface. Spruce and some alpine fir mixed with cedar, hemlock, and Douglas fir occur on the terraces on the higher slopes. Below the true subalpine spruce – alpine fir forests, they form a simpler mixture with Douglas fir. The extreme eastern end of the mapped area includes the northern limits of western white pine. Lodgepole pine in pure stands and in varying mixture follows fires, particularly on drier sites and in the eastern part. Aspen and birch in pure stands or mixed with other species follow fires also and are often dominant in the western part.

A study of the vegetation in mature spruce – alpine fir forests of the Montane Transition Section describes six forest site types (5).

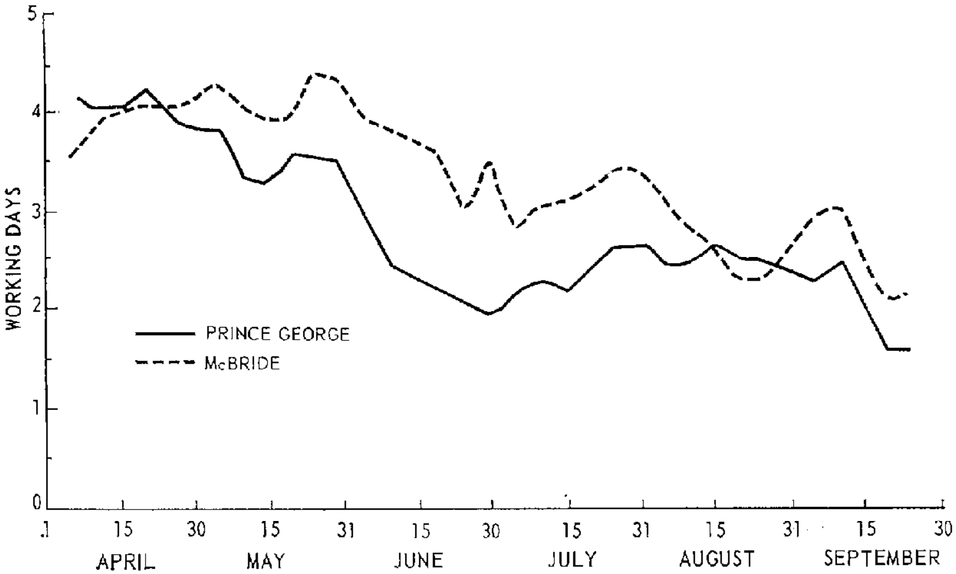


Fig. 4. Average number of working days in each 5-day period of the growing season at Prince George and McBride, 1941–60.

Devil's-club site type. This type consists of large trees with an understory of devil's-club, western thimbleberry, and ferns on moist or wet sites. The average height of mature spruce is 130 ft.

Disporum (fairybells) site type. This type consists of large trees with fairybells and western thimbleberry in the shrub layer. The average height of dominant mature spruce is 123 ft.

Aralia – oak fern site type. Trees are often in clumps with more alpine fir and an understory of shrubs, oak fern, wild sarsaparilla, western coolwort, and some moss. This moist site has the average height of the dominant mature spruce as 117 ft.

Bunchberry – moss site type. This type consists of moderately dense tree cover and a dense understory of small alpine fir. Shrubs and herbs are black huckleberry, shiny-leaved meadowsweet, black twinberry, bunchberry, queen's-cup, twinflower, and rattlesnake plantain, with a continuous cover of moss. The average height of dominant mature spruce on this dry site is 111 ft.

Horsetail – peat moss site type. This type consists of narrow-crowned widely spaced trees with an understory of mountain alder, hardhack, ovalleaf blueberry, field horsetail, ferns, Indian reed grass, small-flowered sedge, swamp starflower, and sphagnum mosses. The average height of dominant mature spruce in this wet site is 95 ft.

Black twinberry – nettle site type. This type is one of several small river bottom sites irregularly stocked with conifers and an understory of mountain alder, black twinberry, and Lyall nettle. This moist to wet site has dominant mature spruce 133 ft high.

List of Species

Common name	*Scientific name*
TREES	
aspen, trembling	*Populus tremuloides* Michx.
birch, white	*Betula papyrifera* Marsh.

TREES *(continued)*

Common name	Scientific name
cedar, western red	*Thuja plicata* Donn
cottonwood, black	*Populus trichocarpa* Torr. & Gray
fir, alpine (balsam)	*Abies lasiocarpa* (Hook.) Nutt.
fir, Douglas	*Pseudotsuga menziesii* (Mirb.) Franco
hemlock, western	*Tsuga heterophylla* (Raf.) Sarg.
pine, lodgepole	*Pinus contorta* Dougl. var. *latifolia* Engelm.
pine, western white	*P. monticola* Dougl.
spruce, black	*Picea mariana* (Mill.) B.S.P.
spruce, Engelmann	*P. engelmanni Parry* (Engelm.)
spruce, white	*P. glauca* (Moench) Voss
SHRUBS	
alder, mountain	*Alnus tenuifolia* Nutt.
birch, scrub	*Betula glandulosa* Michx.
blueberry, ovalleaf	*Vaccinium ovalifolium* Smith
devil's-club	*Oplopanax horridus* (Sm.) Miq.
hardhack	*Spiraea menziesii* Hook.
huckleberry, black	*Vaccinium membranaceum* Dougl.
laurel, pale	*Kalmia polifolia* Wang.
meadowsweet, shiny-leaved	*Spiraea lucida* Dougl.
thimbleberry, western	*Rubus parviflorus* Nutt.
twinberry, black	*Lonicera involucrata* (Richards.) Banks
willows	*Salix* spp.
HERBS	
bearberry	*Arctostaphylos uva-ursi* (L.) Spreng.
bunchberry	*Cornus canadensis* L.
coolwort, western (foam flower)	*Tiarella unifoliata* Hook.
fairybells *(Disporum)*	*Disporum oreganum* (S. Wats.) Benth. & Hook.
fern, oak	*Gymnocarpium dryopteris* (L.) Newm.
fireweed	*Epilobium angustifolia* L.
grass, Indian reed	*Cinna latifolia* (Trev.) Griseb.
hellebore, false	*Veratrum viride* Ait.
horsetail, field	*Equisetum arvense* L.
nettle, Lyall	*Urtica lyallii* S. Wats.
plantain, rattlesnake	*Goodyera oblongifolia* Raf.
queen's-cup	*Clintonia uniflora* (Schult.) Kunth
sarsaparilla, wild *(Aralia)*	*Aralia nudicaulis* L.
sedge, small-flowered	*Carex pauciflora* Lightf.
starflower, swamp	*Trientalis arctica* Fisch.
twinflower	*Linnaea borealis* L. subsp. *longiflora* Hultén
MOSSES	
moss, large light green peat	*Sphagnum squarrosum* Crome; *S. recurvum* P. Beauv.
moss, peat	*S. fuscum* (Schimp.) Klingr.; *S. rubellum* Wils.

Soil Parent Materials

The entire surveyed area was covered with ice during the Wisconsin stage of the Pleistocene epoch (1). North and south of Giscome village several rock knolls occur at elevations of 2,900 and 3,000 ft. With the exception of these rock outcrops, the area is mantled by glacial drift.

The glacial drift (Fig. 5) within the Rocky Mountain Trench between Tête Jaune and Giscome Rapids contains material of eastern origin. The direction of flow of the final glaciation was from the northeast toward the southwest. The Chilako soils have developed on this glacial till.

Following the retreat of the glacier, the uplands and then the higher valleys were exposed. Ice barriers led to the formation of proglacial lakes (Fig. 3), which filled the valleys and covered the uplands to an elevation of 2,600 ft. Meltwater streams carried coarse-textured outwash sediments from the decaying ice front into the lakes and deposited it in their channels, on lake shores, and on top of stagnant ice. The decay of the stagnant ice resulted in the formation of kettles. On these pitted outwash plains and deltas the surface is frequently broken by large steep-sided pits or scars. The soils associated with this topography and derived from these sediments are the Eena, Eaglet, and Seebach.

The clay fractions of the outwash sediments were deposited in a glacial lake and are the parent material of the Pineview soils. The fine sands and silts that were subsequently deposited over the glacial till and lacustrine clays are the parent materials of the Bednesti and Bowron soils.

The glacial till above the periphery of the glacial lake was modified by wave action. The resulting gravel beaches and sorted till are the parent materials of the Gunniza soils.

Most of the glacial drift in the surveyed area of the Rocky Mountain Trench has been mantled by postglacial sediments. Glacial till is found above the valley floor and is confined to narrow moraines adjacent to the mountain wall on either side of the Trench. The till shows evidence of severe erosion, is very stony, and contains many large boulders. The matrix is coarse textured and sandy. Kiwa soils have developed from this material.

The mountains enclosing the Trench contribute colluvial materials, which extend over the original glacial deposits. The colluvium near the source is coarse textured and stony and is the parent material of the Tumbledick soils. The fine-textured colluvium was carried farther and spread over the valley floor and is the parent material of the Eddy soils.

As the ice receded, barriers across the Trench caused the formation of small proglacial lakes. A barrier near the mouths of the McKale and McIntosh rivers caused a lake, which had a maximum elevation of approximately 2,900 ft. The Raush and Doré soils have developed on the sediments deposited in this lake. The Hutton soils have developed on sediments deposited in a laking section immediately upstream from Grand Canyon.

The glacial lakes persisted for a considerable period of time as evidenced by the deep depositions of varved clays. When the ice barriers melted, the lakes drained and river and stream drainage was restored. The Fraser River began to reoccupy its preglacial channel. Coarse sediments washed from the glacial drift by the Fraser formed the first present-day terraces of the river. These sediments are the parent materials of

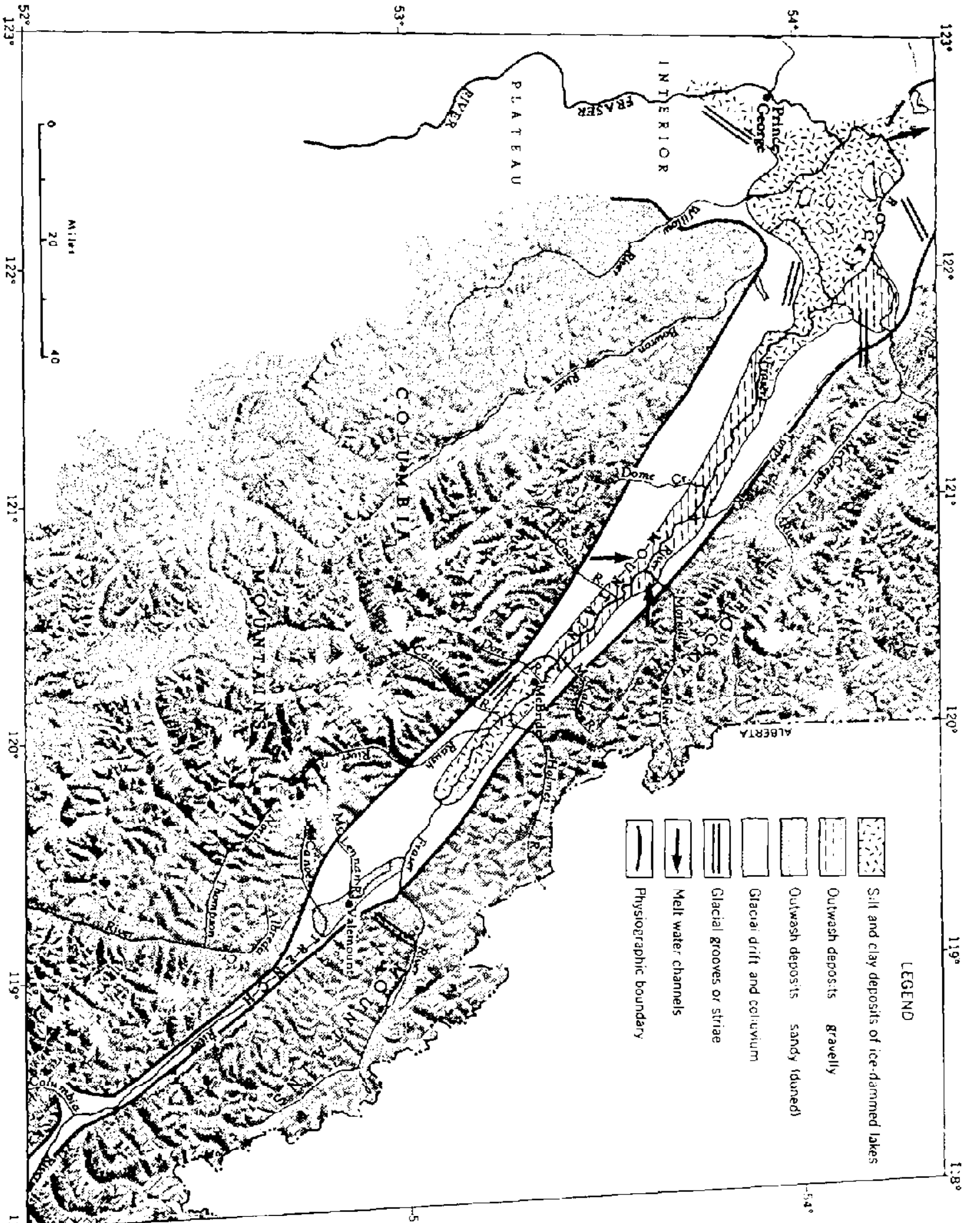


Fig. 5. Glacial geology and physiographic divisions in the upper part of the Fraser Valley.

the Giscome, Toneko, and Longworth soils. As the river approached its present grade, the rate of flow decreased and the most recent alluvium was deposited. These recent sediments are the parent materials of the Fraser and McGregor soils.

An outwash plain extends from Canoe Mountain to Tête Jaune and covers the trench floor. The Fraser, Canoe, and McLennan rivers flow through this section. These rivers have contributed the coarse materials that formed this plain. The sands are duned in the vicinity of Valemount. The Valemount soils have developed on these reworked sediments.

The parent material of the Moxley soils is deep organic deposits of fibrous and woody peat formed in low-lying depressions. The Aleza soils have developed on a shallow mixture of muck and mineral soil overlying the fine-textured, alluvial lacustrine deposits.

SOIL FORMATION, MAPPING, AND CLASSIFICATION

Soil Formation

Climate, vegetation, parent material, relief, and time are the five main factors influencing soil formation. All of these factors interact in the genesis of a soil. In some situations, one of these factors may dominate the formation of a given soil; however, usually the combined forces of the five factors are of primary importance to its present nature. The factors have interacted in such a way that podzolization and gleysation are the dominant processes affecting soil formation in this area. The greatest portion of the surveyed area is occupied by podzolic soils.

Podzolization occurs in forested sections that have surface layers of organic litter. There are two distinct processes active in podzolization, both of which may proceed simultaneously. One process leads to the formation of Gray Wooded soils, the second to the formation of Podzol soils. When features of both processes are recognizable, the soil is described as bisequa with the term Gray Wooded or Podzol indicating the dominant process.

In the formation of a Gray Wooded soil, bases are leached from the exchange complex in the solum; clay in suspension moves from an upper to a lower layer or soil horizon. This causes the upper horizon (Ae) to become bleached and acid in reaction. The translocated clay is deposited as films (clay skins) or as clay bridges in the pores or on the faces of the structural aggregates in the Bt horizon. Small amounts of sesquioxides and organic matter move from the Ae horizon to the Bt horizon. There is usually an accumulation of bases below the Bt horizon.

Podzol formation is accomplished when the bases are leached from the solum; sesquioxides are mobilized in the upper soil layer and move probably as organic complexes to a lower layer. The upper leached Ae horizon is acid in reaction and the accumulation of sequioxides (Fe and Al) and humus in the Bf horizon may form an ortstein horizon.

Soil material slowly permeable to water or saturated with water in the presence of organic matter is subject to gleysation. Sections in which gleysation is active generally support a luxuriant growth of water-loving plants. Because of the wetness, plant remains decay slowly and organic materials accumulate. Under the buildup of organic matter, organic compounds are released. Fe is reduced to a soluble form and the solubility of Ca, Mg, and Mn is increased. At depth, a bluish horizon called a gley is formed. The soil horizons between the peat and the gley have a dull, grayish matrix and yellowish and brownish mottles.

Soils formed as a result of other soil-forming processes may also have gleyed horizons. Because of position or material, alternating wet and dry conditions prevail and the soil horizons are mottled.

Soils developed on materials with a low base status and under a mixed-forest vegetation may not develop into Podzolic soils. These soils develop Ah horizons that may be slightly enriched with sesquioxides but lack distinct eluvial and illuvial horizons. Such soils represent a genetic stage between Regosolic and Podzolic soils and are classified as Acid Brown Wooded soils.

Regosolic soils, due to their youth or to the nature of the parent materials, lack distinct or recognizable evidence of eluviation or illuviation.

Soil Mapping

Traverses were made by car, by boat, and on foot. The northern plateau was covered by car or on foot traverses over logging roads. The southern part of the area from Lamming Mills to Albreda was surveyed in a similar manner. The portion between these two sections, which lies within the Trench and adjacent to the Fraser River, was surveyed by making traverses from riverboat stops. A few sections were surveyed from railway stopovers.

The soils were systematically studied by examination of profiles in test pits. All pertinent information concerning the soil and its location and environment was carefully recorded. Representative samples of typical soils were collected for laboratory analyses.

Soil Classification

The factors contributing to soil formation interact to produce one or many soil individuals. The purpose of soil classification is to describe and identify the individuals, placing them in an order or arrangement so that they can be remembered and we can see the relationships among them. Soil individuals derived from similar parent material that are similar with respect to kind, arrangement, and thickness of soil horizons are grouped into a soil series. The series is given a name, usually of a local river, lake, or town.

Generally, the differences in properties that identify a soil series must be observable in the field. These properties and features are used as a basis for soil mapping. The area and extent are determined and placed on a soil map. Sections dominated by external characteristics rather than by soil development are described as land types. Two classes, eroded and rough broken land, are examples of land types. Some map units are a complex comprising two or more series. These sections are intimate mixtures of soil series and separation was not possible in this survey.

Soil series are grouped into great soil groups and subgroups. Soils having the same diagnostic horizons and a similar horizon sequence are in one great soil group. Mineral soils in the surveyed area are classified into five great soil groups and are described below. Organic soils are unclassified. The classification of the soils used in this report (Table 5) is according to the Report on the Fifth Meeting of the National Soil Survey Committee of Canada (1963). A comparison of this classification with that of 1968 is given in Table 6.

Gray Wooded Great Group

Gray Wooded soils (Fig. 6) have organic surface horizons (L – F or L – H), light-colored eluvial horizons (Ae), and illuvial horizons (Bt) in which clay is the main accumulation product. These soils are found on till in the northern plateau section and are the predominant soils on lake sediments of the Prince George and McBride basins and the smaller glacial lake near Grand Canyon. Four subgroups are recognized in the area.

The Orthic Gray Wooded soils have Ae and Bt horizons and may have up to 2 inches of Ah horizon. Slight mottling may occur in the lower Ae horizon. The Raush and Eddy soils belong to this subgroup.

Gleyed Gray Wooded soils have the same type of profile as the above subgroup but with mottling and commonly duller colors in the Ae and Bt horizons than the associated well-drained soils, due to periodic wetness. The Pineview soils belong to this subgroup.

The Bisequa Gray Wooded soils have a podzolic profile developed in the Ae horizon and a continuous textural Bt horizon. Some of the soils in the Chilako complex and the Bednesti, Bowron, and Hutton soils belong to this subgroup.

The Gleyed Dark Gray Wooded soils have Ah horizons more than 2 inches thick and mottled Ae and Bt horizons. Doré soils belong to this subgroup.

Podzol Great Group

Podzol soils (Fig. 7) have organic surface horizons (L – F or L – H), light-colored eluvial horizons (Ae), and illuvial horizons (Bf or Bfh) in which sesquioxides and organic matter have accumulated. The solum is generally moderately to strongly acid. These soils occur throughout the area on medium- and coarse-textured materials. Three subgroups occur in the area.

The Orthic Podzol soils have Ae horizons more than 1 inch thick and friable Bf horizons of high chroma. Five soil series, Kiwa, Toneko, Giscome, Gunniza, and Eena, are classified as Orthic Podzols.

The Ortstein Podzol soils are similar to Orthic Podzols, but have continuous or interrupted cemented B horizons (Bfc). The Seebach soils belong in this subgroup.

The Bisequa Podzol soils have podzolic sola (Ae and Bf horizons) underlain by textural Bt horizons. The Eaglet and Longworth soils belong to this subgroup.

Acid Brown Wooded Great Group

Acid Brown Wooded soils lack distinct eluvial and illuvial horizons. An organic litter horizon (L – H) is usually present; a distinct Ah horizon is lacking. The parent material is usually of low base saturation. The only soils classified as Acid Brown Wooded are the Valemount soils, which belong to the Orthic subgroup.

Regosol Great Group

Regosol soils lack discernible horizons or have only organic surface (L – H) horizons up to 12 inches thick, or weakly developed (nonchernozemic) organic – mineral Ah horizons. These soils occur mainly along the Fraser River and its tributaries. They are confined to recent alluvium and colluvium. Profiles belonging to the Orthic Regosol subgroup (with thin or weak Ah horizons), the Mull subgroup (with 2 inches or more of Ah horizon), and the Gleyed subgroup (imperfectly drained regosols) were recognized. Some of the soils in the Fraser complex are Gleyed Mull Regosols, the McGregor soils are Mull Regosols, and the Tumbledick soils are Orthic Regosols.

Eluviated Gleysol Great Group

Eluviated Gleysol soils have mottled Aeg and mottled Btg horizons and less than 12 inches of organic horizons. The Low Humic Eluviated Gleysol subgroup has Ah horizons less than 2 inches thick. The Aleza soils and some of the soils in the Chilako complex belong to this subgroup.

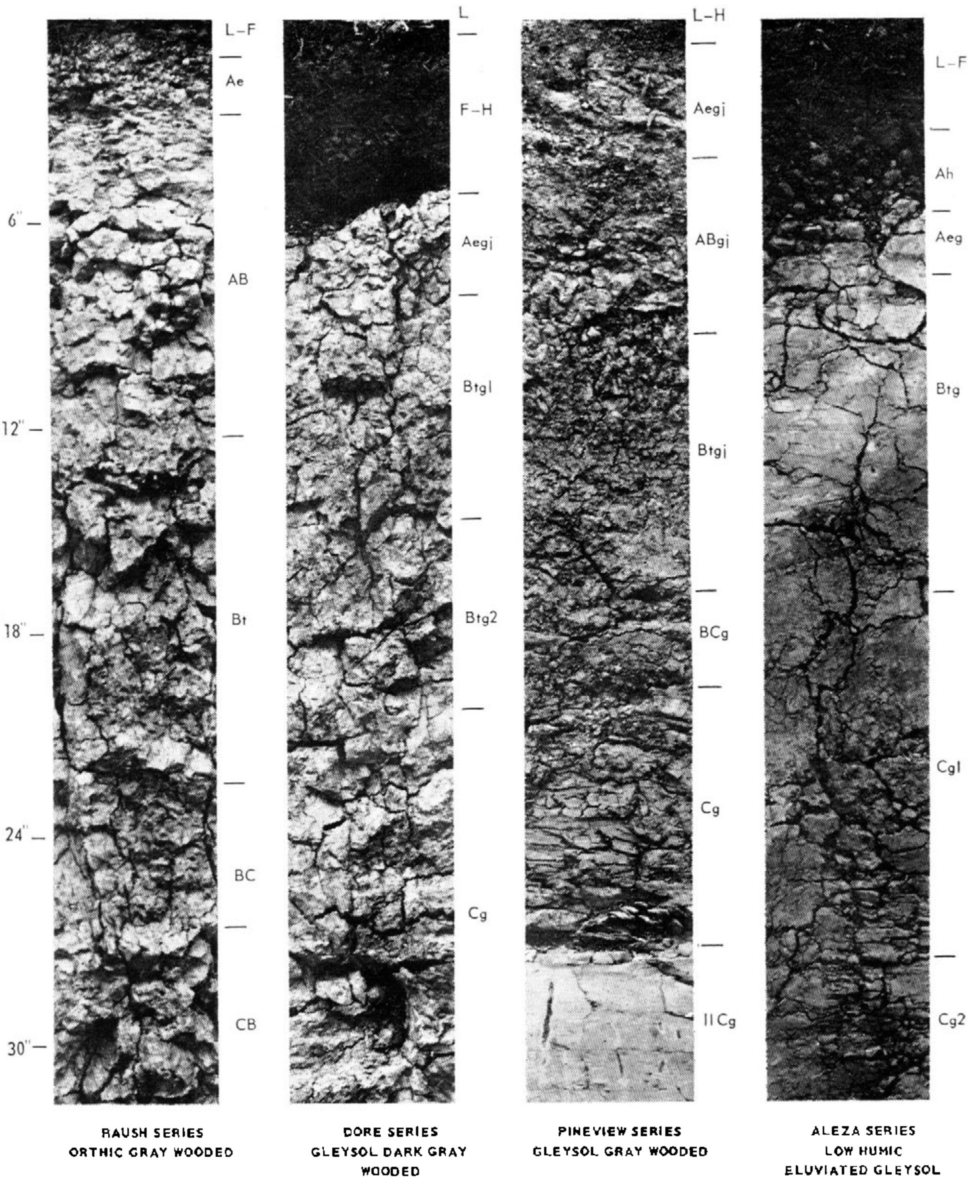
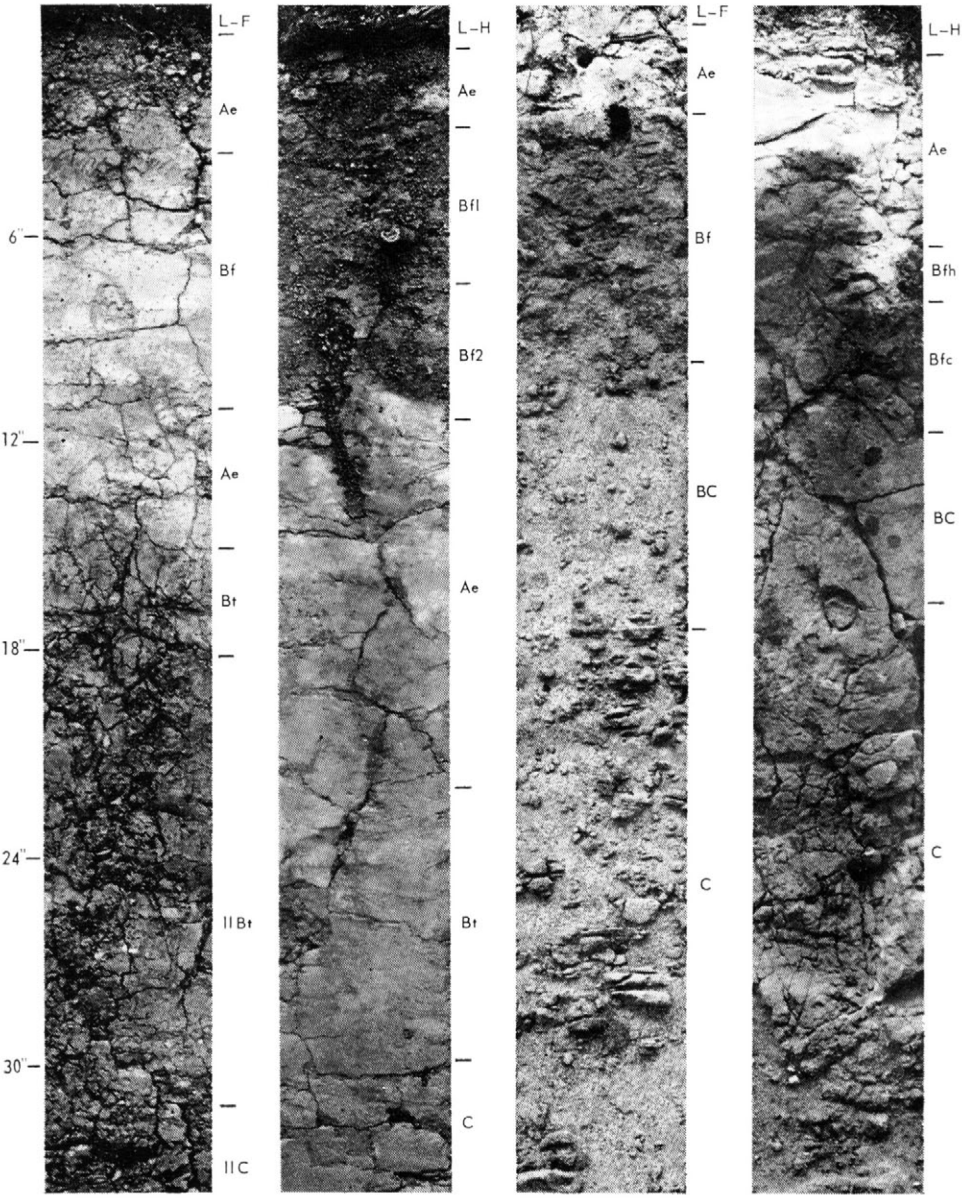


Fig. 6. These soils represent a sequence of drainage classes on fine-textured lacustrine deposits.



BEDNESTI SERIES
BISEQUA GRAY WOODED

EAGLET SERIES
BISEQUA PODZOL

TONEKO SERIES
ORTHIC PODZOL

SEEBACH SERIES
ORTSTEIN PODZOL

Fig. 7. These soils represent a group of Podzolic soils developed on coarse- and medium-textured deposits.

Table 5. Classification of the Soils in the Upper Part of the Fraser Valley in the Rocky Mountain Trench

Soils Developed on Glacial Till Deposits	
On weakly calcareous grayish brown clay loam	
Chilako Complex	Bisequa Gray Wooded
	Orthic Gray Wooded
	Gleyed Gray Wooded
	Orthic Gleysol
	Low Humic Eluviated Gleysol
On calcareous olive brown stony loam	
Kiwa Series	Orthic Podzol
Soils Developed on Lacustrine Deposits	
On weakly calcareous grayish brown clay loam	
Raush Series	Orthic Gray Wooded
Hutton Series	Bisequa Gray Wooded
Doré Series	Gleyed Dark Gray Wooded
On moderately calcareous stratified dark brown and brown clay and grayish brown silt	
Pineview Series	Gleyed Gray Wooded
Aleza Series	Low Humic Eluviated Gleysol
On moderately calcareous stratified pale brown silt	
Bednesti Series	Bisequa Gray Wooded
On moderately calcareous yellowish brown very fine sandy loam to sandy loam sediments overlying stratified pale brown silt	
Bowron Series	Bisequa Gray Wooded
Eaglet Series	Bisequa Podzol
Soils Developed on Alluvial Deposits	
On moderately calcareous yellowish brown loam and sandy loam alluvium	
Fraser Complex	Mull Regosol
	Orthic Podzol
On moderately calcareous yellowish brown fine sand and sand alluvial floodplain deposits	
McGregor Series	Mull Regosol
On noncalcareous yellowish brown fine sandy loam alluvial fan deposits	
Eddy Series	Orthic Gray Wooded
On noncalcareous yellowish brown and brown very fine sandy loam and sandy loam alluvial terrace deposits	
Longworth Series	Bisequa Podzol
Toneko Series	Orthic Podzol
On noncalcareous sand over gravel alluvial terrace deposits	
Giscome Series	Orthic Podzol
Soils Developed on Outwash and Beach Deposits	
On noncalcareous grayish brown gravelly sandy loam beach material	
Gunniza Series	Orthic Podzol
On noncalcareous yellowish brown loamy sand outwash	
Eena Series	Orthic Podzol
Seebach Series	Ortstein Podzol
Valemount Series	Orthic Acid Brown Wooded
Soils Developed on Stony Colluvial Deposits	
On noncalcareous stony loamy sand	
Tumbledick Series	Orthic Regosol
Soils Developed on Organic Deposits	
Moxley Series	Peat

Table 6. Classification of Soils in the Upper Part of the Fraser Valley According to the System of the National Soil Survey Committee of Canada

	1963	1968
Aleza	Low Humic Eluviated Gleysol[1]	Low Humic Eluviated Gleysol[2]
Bednesti	Bisequa Gray Wooded	Bisequa Gray Wooded (Bisequa Gray Luvisol)
Bowron	Bisequa Gray Wooded	Bisequa Gray Wooded (Bisequa Gray Luvisol)
Chilako	Bisequa Gray Wooded	Bisequa Gray Wooded (Bisequa Gray Luvisol)
	Gleyed Gray Wooded	Gleyed Gray Wooded (Gleyed Gray Luvisol)
	Orthic Gray Wooded	Orthic Gray Wooded (Orthic Gray Luvisol)
	Orthic Gleysol	Orthic Gleysol
	Low Humic Eluviated Gleysol	Low Humic Eluviated Gleysol
Doré	Gleyed Dark Gray Wooded	Gleyed Dark Gray Wooded (Gleyed Dark Gray Luvisol)
Eaglet	Bisequa Podzol	Bisequa Humo-Ferric Podzol
Eddy	Orthic Gray Wooded	Orthic Gray Wooded (Orthic Gray Luvisol)
Eena	Orthic Podzol	Orthic Humo-Ferric Podzol
Fraser	Mull Regosol	Orthic Regosol
	Orthic Podzol	Degraded Dystric Brunisol
Giscome	Orthic Podzol	Orthic Humo-Ferric Podzol
Gunniza	Orthic Podzol	Orthic Humo-Ferric Podzol
Hutton	Bisequa Gray Wooded	Bisequa Gray Wooded (Bisequa Gray Luvisol)
Kiwa	Orthic Podzol	Orthic Humo-Ferric Podzol
Longworth	Bisequa Podzol	Bisequa Humo-Ferric Podzol
McGregor	Mull Regosol	Orthic Regosol
Moxley	Organic	Mesisol (sphagnic phase)
Pineview	Gleyed Gray Wooded	Gleyed Gray Wooded (Gleyed Gray Luvisol)
Raush	Orthic Gray Wooded	Orthic Gray Wooded (Orthic Gray Luvisol)
Seebach	Ortstein Podzol	Orthic Humo-Ferric Podzol
Toneko	Orthic Podzol	Orthic Humo-Ferric Podzol
Tumbledick	Orthic Regosol	Orthic Regosol
Valemount	Orthic Acid Brown Wooded	Orthic Dystric Brunisol

[1]Classification according to Report of the Fifth Meeting of the National Soil Survey Committee of Canada. Winnipeg, Manitoba, 1963.

[2]Classification according to Proceedings of the Seventh Meeting of the National Soil Survey Committee of Canada. Edmonton, Alberta, 1968.

DESCRIPTIONS OF THE SOILS

In this section, the soils are described in alphabetical order. A typical soil profile is described in detail under each series name. Topographic classes that represent additional elements of classification and mapping are shown on the accompanying soil map. The utilization of these soils is indicated in the section describing soil capability and in Table 7. The acreage of each soil is also given in Table 7.

In the descriptions, the soil color is followed by a set of symbols that designate the color in the Munsell system.* The letter m means moist, d means dry, and c

*Munsell Color Company, Incorporated, Baltimore 18, Maryland, USA.

means crushed soil. For an explanation of other details used in the descriptions see the definitions for texture, structure, consistence, and boundary in the glossary.

Aleza Series

The Aleza soils (Fig. 6) occur in the northern part of the mapped area. They have developed on moderately calcareous, stratified lacustrine clay and silt and are found in depressions (Fig. 8) usually associated with the Pineview, Bednesti, and Bowron soils. They are poorly drained soils and in the spring some of the sites may be subject to flooding. Runoff is slow, internal drainage is slow, and the water-holding capacity is high.

These soils are slightly acid, moderately high in organic matter content, and well supplied with plant nutrients.

The Aleza soils are generally associated with the horsetail – peat moss forest site type. Where the land has been disturbed by logging or burning, the vegetation consists usually of willow, sedges, and grasses.

Fig. 8. A farm on Aleza soils near Giscome. The soils in the background are Pineview, Bednesti, and Chilako.

An Aleza soil, a Low Humic Eluviated Gleysol, is described as follows:

Horizon	*Depth Inches*	
L – F	2 – 0	Decomposed slough grasses, sedge, willow leaves, and woody remains.
Ah	0 – 2	Black (10YR 2/1 m) clay loam; moderate, fine granular; friable; pH 6.4.
Aeg	2 – 5	Dark grayish brown (2.5Y 4/2 m) clay loam; many, gray mottles; pH 6.5.

Btg	5 – 14	Grayish brown (2.5Y 5/2 m) clay; common, distinct, brown (7.5YR 5/4 m) mottles; weak, coarse columnar to amorphous; very plastic; pH 6.8.
Cg1	14 – 24	Grayish brown (2.5Y 5/2 m) clay; common, prominent, strong brown (7.5YR 5/8 m) mottles; amorphous; plastic; pH 6.8.
Cg2	24 +	Grayish brown (2.5Y 5/2 m) clay; many, gray mottles; amorphous; plastic; pH 6.5.

Use. Most of the Aleza soils are still under native vegetation. Texturally they are suitable for agriculture, but their development has been slow because of heavy forest cover, poor drainage, and local climate. Undrained they are suitable for pasture; drained they are capable of producing reasonably good yields of forage.

Approximately 63% of the Aleza soils are Class 4, that is, physically marginal for sustained arable agriculture. Only 6% of these soils are rated as Class 3.

Bednesti Series

The Bednesti (Fig. 7) soils occur in the northern part of the mapped area where they are associated with the Pineview soils. They have developed on moderately calcareous stratified silt and occupy level, gently sloping, and steeply sloping topography. On steep slopes these soils are subject to severe erosion. These soils are well drained with medium runoff, medium internal drainage, and a moderately high water-holding capacity.

The Bednesti soils are slightly acid, low in organic matter content, and well supplied with plant nutrients.

These soils are generally associated with the bunchberry – moss forest site type. On logged areas, fireweed and willows (Fig. 9) and the occasional Douglas fir are found. On slightly moister areas the *Aralia* – oak fern forest site type occurs.

Bednesti very fine sandy loam, a Bisequa Gray Wooded soil, is described as follows:

Horizon	*Depth Inches*	
L - F	1 – 0	Litter of leaves, twigs, and needles over dark brown and very dark brown moderately decomposed conifer needles, twigs, and mosses.
Ae	0 – 4	Light brownish gray (10YR 6/2 m), light gray (10YR 7/2 d) very fine sandy loam and silt loam; weak, fine platy; friable; gradual, wavy boundary; pH 4.5.
Bf	4 – 10	Dark yellowish brown (10YR 4/4 m), light yellowish brown (10YR 6/4 d) silt loam; weak, fine granular; very friable; a few iron concretions at 8 to 10 inches depth; pH 5.0.
Ae	10 – 14	Yellowish brown (10YR 5/4 m), grayish brown (10YR 5/2 d) silt loam; weak, fine granular; friable; pH 5.5.
Bt1	14 – 18	Dark grayish brown (10YR 4/2 m), brown (10YR 5/3 d) silty clay loam; moderate, medium and fine subangular blocky; firm; whitish silica coating on some peds; pH 6.0.
Bt2	18 – 32	Brown to dark brown (10YR 5/3 – 4/3 m), yellowish brown (10YR 5/4 d) silty clay loam; coarse, subangular blocky; firm; stratified near boundary; pH 6.8.
Ck	32 +	Very pale brown (10YR 7/4 d) stratified silt; strata 1/8 to 1 inch thick; firm; hard; weakly effervescent; pH 7.0.

Use. The Bednesti soils are medium textured, friable, and easily cultivated throughout a wide range of moisture conditions. They are quite fertile (Table 8) and cropping practices are only limited by the length of the growing season and steep slopes. The steep slopes are susceptible to erosion.

Of the 32,850 acres mapped as Bednesti soils, 15,200 acres are Class 4, 3,250 acres are Class 5, and 14,400 acres are Class 7. Most of the land in Class 7 had steep slopes and rock outcrops.

Fig. 9. Ground cover of fireweed and willow after logging and slash-burning on gently sloping Bednesti silt loam.

Bowron Series

The Bowron soils occur in the northern part of the mapped area and are associated with the Pineview and Bednesti soils. The moderately coarse-textured materials on which these soils have developed usually overlie a medium-textured stratified material, which influences drainage. There are a number of drainage members, each of which reflects the position and depth of the underlying sediments. The topography is strongly sloping and the soils on steep slopes are subject to severe erosion.

The Bowron soils are moderately well drained with medium runoff, medium internal drainage, and moderately high water-holding capacity. They are very strongly to strongly acid, low in organic matter content, and moderately well supplied with plant nutrients.

Vegetation usually indicates different drainage members. Devil's-club and *Aralia* – oak fern forest site types commonly occur on Bowron soils. The former site type occurs in imperfectly drained areas and the latter in moderately well drained areas.

Bowron very fine sandy loam, a Bisequa Gray Wooded soil, is described as follows:

Horizon	*Depth Inches*	
L – F	1 – 0	Decomposing coniferous needles and plant remains.
Ae	0 – 3	Dark grayish brown (10YR 4/2 m), light gray (10YR 7/2 d) loam; moderate, fine granular; friable; pH 4.9.
Bf	3 – 8	Dark yellowish brown (10YR 4/4 m), yellow (10YR 7/6 d) very fine sandy loam and silt loam; moderate, fine granular; very friable; gradual, smooth boundary; pH 5.0.
Bt1	8 – 11	Dark yellowish brown to light olive brown (10YR 4/4 to 2.5Y 5/4 m), very pale brown (10YR 7/4 d) silt loam; moderate, fine and medium granular; friable; pH 5.4.
Bt2	11 – 15	Olive brown (2.5Y 4/4 m), very pale brown (10YR 7/4 d) silt loam; moderate, coarse and medium granular; firm; pH 5.9.
BC	15 – 28	Olive brown (2.5Y 4/4 m), very pale brown (10YR 7/4 d) silty clay loam; compound, weak, coarse platy breaking to medium subangular blocky; firm; pH 6.1.
C	28 +	Dark grayish brown (2.5Y 5/2 m), pale brown (10YR 6/3 d) silt loam; stratified; few, yellowish brown mottles below 20 inches depth; pH 6.2.

Use. Bowron soils are medium textured and can be cultivated throughout a wide range of moisture conditions. They are moderately fertile and cropping practices are limited by the length of the growing season, steep slopes, and in some cases, drainage. The steep slopes are susceptible to erosion.

Of the 36,700 acres of Bowron soils in the mapped area, 3,280 are Class 3, 14,600 acres are Class 4, 17,900 acres are Class 5, and 920 acres are Class 7. The principal limiting factors for agriculture are the climate, the topography, and the presence of the underlying fine-textured material that can restrict the drainage.

Chilako Complex

The Chilako soils are confined to the plateau uplands in the northwest part of the mapped area. Within the complex, Podzolic and Gleysolic soils occur on the drumlinized till plain (Fig. 8), which extends into the area from the northwest. Gray Wooded and Podzol soils occur on the drumlin slopes and Gleysols and Organic soils occupy the depressions. The parent materials are variable deposits of sandy and clayey till with concentrations of gravel and stones along the crests of ridges.

Where Chilako soils occur on isolated till knolls within the Fraser Basin, they have been delineated as mapping units consisting of Chilako and Gunniza soils. Around the periphery of the northern laking basin, the Chilako soils occur with the Tumbledick soils on very steeply sloping and hilly topography. North of Sinclair Mills, the Chilako soils are on the irregular steeply sloping, drumlinized terrain characteristic of the McGregor Plateau.

The native vegetation consists of a spruce – alpine fir forest with the bunchberry – moss site type occurring on the well-drained slopes and the black twinberry – nettle site type in the poorly drained areas.

Although a number of Gray Wooded subgroups including the Bisequa and Gleyed Gray Wooded subgroups occur, a moderately well drained Bisequa Gray Wooded profile on fine-textured parent material is described below:

Horizon	*Depth Inches*	
L – H	3 – 0	Decomposing needles, twigs, and moss.
Ae	0 – 4	Light brownish gray (10YR 6/2 m) sandy loam; weak, fine granular; loose; pH 4.5.
Bfh	4 – 9	Dark yellowish brown (10YR 4/4 m) sandy clay loam; weak, fine columnar breaking to moderate, coarse granular; firm; pH 4.8.
Bt	9 – 12	Light olive brown (2.5Y 5/4 m) clay loam; moderate, medium subangular blocky; firm; pH 5.0.
BC	12 – 24	Light gray (5Y 7/1 m) clay loam; few, fine, prominent, yellowish brown (10YR 5/6 m) mottles; moderate, medium blocky; firm, pH 6.0.
C	24 +	Light-gray (5Y 7/1 m) clay loam; few, fine, faint, yellowish brown (10YR 5/6 m) mottles; coarse subangular pseudo-blocky; firm; amosphous; pH 6.8.

Use. All 83,500 acres of soils in the Chilako complex are rated as Class 7. Topography, climate, and stoniness are the main limitations.

Doré Series

The Doré soils (Fig. 6) are confined to a section extending from McKale River to the Raush River and occupy the lower and depressional sites associated with the Raush soils in the McBride basin (Fig. 10).

The soils are slightly acid but well supplied with Ca, Mg, and K. They are moderate in organic matter and in moisture-holding capacity. Runoff is very slow or ponded and internal drainage is very slow. During the winter and spring water saturates the soil much of the time and once saturated the soil stays wet a long time.

The native vegetative cover is spruce with some willow and mountain alder.

The Doré clay, a Gleyed Dark Gray Wooded soil, is described as follows:

Horizon	*Depth Inches*	
L	4 – 3	Litter of grass, roots, and moss.
F	3 – 0	Partially decomposed moss, grass, and woody herbs.
Ah	0 – 2	Black (10YR 2/1 m) loam; strong, fine granular; firm, hard; pH 6.2.
Aegj	2 – 5	Dark grayish brown (10YR 4/2 m) clay; common, medium, prominent, yellowish brown (10YR 5/6 m) mottles; moderate, medium subangular blocky; firm; hard; at the upper boundary the peds have very dark gray (10YR 3/1 m) coatings of organic matter; peds in the lower portion have gray silica coatings; pH 6.5.
Btg1	5 – 12	Gray (10YR 5/1 m) clay; common, prominent, yellowish brown (10YR 5/4 m) mottles; strong, medium columnar breaking to strong, medium blocky; firm.
Btg2	12 – 17	Gray to dark gray (10YR 5/4 – 4/1 m) clay; many, prominent, yellowish brown (10YR 5/4 m) mottles; amorphous; waxy surfaces; firm; pH 6.8.
Cg	17 +	Dark gray (10YR 4/1 m) silty clay; many, prominent, brownish yellow to yellowish brown (10YR 6/6 – 5/6 m) mottles; amorphous; stratified; pH 7.3.

Use. Much of the portion covered by the Doré soils has been cleared and used for pasture and forage. In some places the soil might be improved by artificial drainage. Oats and barley can be grown, but hay and pasture are probably better suited to these soils. Climate and drainage are the main restrictions to use. In a total of 5,600 acres, 4,500 acres are Class 4, 400 acres are Class 5, and 700 acres are Class 7.

Fig. 10. A cultivated field with the dark-colored Doré soils and the light-colored Raush soils in the foreground and with Kiwa and Tumbledick soils in the background.

Eaglet Series

The Eaglet soils occur in the northern part of the mapped area in association with the Bowron soils and have developed on the same parent material. They are generally better drained than the Bowron soils because of the greater depth to the fine-textured Bt horizon. The soils are permeable and roots penetrate easily. Runoff is slow, internal drainage is medium, and the moisture-holding capacity is high. They are moderately acid, low in organic matter content, and moderately supplied with Ca, Mg, and K.

The medium-textured materials on which the Eaglet soils have developed are underlain by fine-textured sediments. Associated with the Eaglet soils are a number of drainage members all of which reflect the position and depth of the underlying sediments. The ground vegetation usually reflects drainage. The devil's-club forest site type occurs on the Eaglet soils; the black twinberry – nettle site type occurs on the poorly drained land; the *Aralia* – oak fern site and bunchberry – moss site types occur on moderately well drained sections such as along the banks of small stream channels.

Eaglet loam, a Bisequa Podzol (Fig. 7), is described as follows:

Horizon	*Depth Inches*	
F	3 – 0	Moderately decomposed residues of fir needles, lady fern, and devil's-club.
Ae	0 –2.5	Light brownish gray and grayish brown (10YR 6/2 and 5/2 d) loam; weak, medium platy; very friable; pH 5.0.
Bf1	2.5 – 7	Strong brown (7.5YR 5/6 m) loam; medium granular; very friable; diffuse, smooth boundary; pH 5.2.
Bf2	7 – 11	Yellowish brown (10YR 5/6 m) loam; medium granular; friable; diffuse, smooth boundary; pH 5.4.
Ae	11 – 22	Light olive brown (2.5Y 5/4 m) loam; weak, medium platy and moderate, medium subangular blocky; friable; pH 5.7.
Bt	22 – 30	Light olive brown and olive brown (2.5Y 5/4 and 5/5 m) very fine sandy clay loam; moderate, medium subangular blocky; firm; pH 5.8.
C	30 – 35	Olive brown and light olive brown (2.5Y 4/4 – 5/4 m) loamy sand; single grain.
IIC	35 +	Brown (10YR 5/3 m) silt; stratified; plastic; pH 6.0.

Use. All 2,700 acres of Eaglet soils in the mapped area are rated as Class 3. They are good arable soils and should yield reasonably good crops of forage. Because the organic matter content is very low, good management is needed to maintain tilth. Climate is the main limitation.

Eddy Series

The Eddy soils occur in the southern part of the mapped area, mainly between the villages of McBride and Croydon. They are associated with the Raush soils near McBride and with the Toneko soils. The parent material is medium-textured alluvium and colluvium deposited as fans adjacent to the mountain wall. Near McBride the colluvium mantles sediments of the type on which the Raush soils have developed. These soils are gently, moderately, or steeply sloping.

The soils are slightly acid and low in organic matter and available nutrients. They are very permeable and plant roots penetrate easily. Runoff is medium, internal drainage is rapid, and the moisture-holding capacity is medium to low.

The native vegetation consists of trembling aspen, white spruce, white birch, and western red cedar.

Eddy fine sandy loam, an Orthic Gray Wooded soil, is described as follows:

Horizon	*Depth Inches*	
L – F	2 – 0	Litter of leaves, needles, twigs, and bark.
Ae	0 – 3	Gray (10YR 6/1 m), light gray (10YR 7/1 d) very fine sandy loam; weak, medium platy; clear, smooth boundary; pH 5.4.

AB	3 – 6	Light olive brown (2.5Y 5/4 m), yellowish brown (10YR 5/6 d) very fine sandy loam; weak, medium platy; pH 6.5.
Bt	6 – 11	Light olive brown to olive brown (2.5Y 5/4 – 4/4 m) loam; moderate, fine and medium subangular blocky; friable; pH 6.0.
Cgj	11 – 16	Light yellowish brown (2.5Y 6/4 m) fine sandy loam; few, fine, faint, light olive brown (2.5Y 5/4 m) mottles; moderate, medium blocky; friable; pH 6.0.
IIC	16 – 26	Light olive brown (2.5Y 5/4 m) fine sandy loam; pebbles and charcoal scattered through horizon; firm; stratified.

Use. In the surveyed area 300 acres of Eddy soils are rated as Class 3, 6,800 acres as Class 4, and 6,300 acres as Class 5.

Eddy soils are low in plant nutrients, very low in organic matter, and low in productivity. Fertilizer would be required for crops adapted to these soils. Hay and pasture are the best uses for those soils that occur on steeply sloping land or on rough, hummocky microrelief. In dry years the soils will be droughty.

Eena Series

The Eena soils occur in the northern part of the area on gentle, moderate, and steep slopes and are associated with the Bowron soils.

These soils have developed on noncalcareous, coarse-textured outwash. They are well-drained soils with slow runoff, rapid internal drainage, and low moisture-holding capacity. They are very permeable and allow easy penetration of plant roots. The soils are strongly acid, low in organic matter content, and moderately well supplied with bases.

The bunchberry – moss forest site type occurs on the Eena soils.

Eena sandy loam, an Orthic Podzol, is described as follows:

Horizon	*Depth Inches*	
L – F	2 – 0	Decaying litter of moss, conifer needles, and wood twigs.
Ae	0 – 2	Grayish brown (10YR 5/2 d) fine sandy loam, fine platy; friable; pH 4.3.
Bf	2 – 5	Yellowish brown (10YR 5/4 d), dark brown (7.5YR 3/2 m) fine sandy loam; weak, fine granular; very friable; pH 5.6.
BC	5 – 11	Light yellowish brown (2.5Y 6/4 d), yellowish brown to dark yellowish brown (10YR 5/6 – 4/4 m) loamy fine sand; weak, medium granular; friable; pH 6.0.
C	11 – 17	Pale yellow (2.5Y 7/4 d), olive brown (2.5Y 4/4 m) loamy fine sand; amorphous; firm.
IIC	17 +	Pale brown (10YR 6/3 d), olive brown (2.5Y 4/4 m) stratified sand and loamy sand.

Use. These moderately coarse textured soils are often droughty during the summer. They are associated with hilly topography. Eena soils are suited for pasture in the spring and early fall. In the surveyed area 1,900 acres are rated as Class 4, 2,200 acres are rated as Class 5, and 850 acres are rated as Class 7.

Fraser Complex

The soils of the Fraser complex occur in the northwestern part of the mapped area. The complex is composed of Regosolic and Podzolic soils derived from fine- to medium-textured postglacial deposits of the Fraser and Willow rivers. The soils of the complex occur in small, irregular, intricate patterns and because the scale of mapping does not permit the different kinds of soil to be delineated, they have been grouped into a mapping unit called a soil complex.

They are well to imperfectly drained soils with a low to medium water-holding capacity, occurring on gently sloping and occasionally depressional terrain. They are periodically flooded in the winter and the spring.

The soils are medium acid to neutral, medium to low in content of plant nutrients and organic matter.

The native vegetation consists of spruce, balsam, poplar, birch, and less frequently aspen. The black twinberry – nettle site type occurs on some soils of the Fraser complex.

A member of the Fraser complex is described as follows:

Horizon	*Depth Inches*	
F	3 – 0	Moderately decomposed residues of conifer needles, moss, and devil's-club.
Ah	0 – 3	Dark brown (10YR 4/3 m) loam; weak, fine granular; very friable; pH 6.8.
Ae	3 – 5	Grayish brown to dark grayish brown (10YR 5/2 – 4/2 m) loam; weak, fine platy; friable; pH 6.4.
Bm	5 – 9	Grayish brown (10YR 5/2 m) silt loam; weak, medium subangular blocky; friable.
C	9 – 17	Yellowish brown (10YR 5/4 m) fine sandy loam; weak, coarse granular; very friable; pH 7.2.
IIC	17 – 24	Dark yellowish brown (10YR 4/4 m) fine sandy loam; weak, coarse pseudo-granular; very friable; pH 7.2.
IIIC	24 +	Dark brown (10YR 4/3 m) fine sand; single grain; loose; pH 7.5.

Use. Some of the soils of the Fraser complex have been cleared for hay and pasture and small vegetable gardens. They are moderately productive for these crops. The soils are well suited to hay crops that are moderately tolerant of wet conditions, and to many vegetables. Imperfect drainage and susceptibility to flooding limit their use, but this may be overcome by artificial drainage.

In the mapped area, 8,450 acres of Fraser soils are rated as Class 3 and 500 acres as Class 4. A limited acreage of Fraser soils in the Willow Valley was placed in Class 2. These soils, occurring as part of a soil capability complex, are fertile and well drained with no limitations other than the regional climate.

Giscome Series

The Giscome soils are confined to the northwestern part of the mapped area. They are found on the upper terraces adjacent to the Fraser River. The terraces are gently sloping and consist of gravelly sand over coarse gravel. The Giscome soils are well drained with a slow runoff, and have very rapid internal drainage and low water-holding capacity. They are medium to slightly acid and low in organic matter content and plant nutrients.

The native vegetation consists of trembling aspen, white spruce, and alpine fir. The sparse understory is dominantly bearberry where the original vegetation has been disturbed. The bunchberry-moss forest site type occurs on the Giscome soils.

Giscome loamy sand, an Orthic Podzol, is described as follows:

Horizon	*Depth Inches*	
L – H	1 – 0	Litter and decomposing conifer needles, twigs, shrub leaves, and moss.
Ae	0 – 4	Light gray (10YR 7/1 d) and light brownish gray (10YR 6/2 m) loamy sand; weak, fine platy; very friable; pH 5.5.
Bf	4 – 8	Brown (10YR 5/3 d), reddish brown (5YR 5/4 m) sandy loam; single grain; very friable; pH 6.0.
C1	8 – 16	Light yellowish brown (10YR 6/4 d) gravelly loamy sand; amorphous; loose; pH 6.5.
C2	16 +	Grayish brown and brown (10YR 5/2 and 5/3 d) gravelly sand and coarse gravel; stratified.

Use. Only 200 acres of Giscome soils were mapped and these were rated as Class 7. Dissection by erosion into steep-sided gullies is the main factor rendering these soils unsuitable for arable agriculture or permanent pasture.

Gunniza Series

The Gunniza soils occur in the northern part of the mapped area. They are associated with the Chilako soils and have developed on the gravelly materials washed and eroded from the Chilako glacial till. These coarse-textured materials usually occur as narrow, irregular beach deposits along the periphery of the glacial till and occasionally as small, isolated deposits at higher elevations in the laking basin. They occur on moderately, steeply, and very steeply sloping terrain.

The Gunniza soils are strongly acid and low in organic matter content and plant nutrients. They are well drained with very slow runoff, and have very rapid internal drainage and very low water-holding capacity. The soils are very stony.

The native vegetation consists of spruce and aspen with a sparse understory. On undisturbed sites a good growth of moss and bearberry occurs.

Gunniza sandy loam, an Orthic Podzol, is described as follows:

Horizon	*Depth Inches*	
L – H	2 – 0	Litter and decomposing conifer needles, twigs, wood, and moss.
Ae	0 – 7	Light gray (10YR 7/2 d), very pale brown (10YR 7/4 m) sandy loam; weak, fine platy; very friable; pH 4.8.
Bf	7 – 14	Brown (7.5YR 5/4 d), reddish brown (5YR 5/4 m) gravelly sandy loam; fine granular between gravel fabric; pH 5.5.
BC1	14 – 18	Grayish brown (10YR 5/2 d) gravelly sandy loam; single grain; pH 6.2.
BC2	18 – 32	Brown and grayish brown (10YR 5/3 and 5/2 d) gravelly sandy loam; clay bridges between the sand particles; weak, fine to medium subangular blocky; pH 6.6.
C	32 – 48	Stratified sand and gravel; pH 7.0.

Use. There is no agricultural development on these soils. Stoniness and steep topography limit their development. In the mapped area 2,700 acres of Gunniza soils are rated as Class 5 and 6,600 acres as Class 7.

Hutton Series

The Hutton soils occur in areas between the village of Longworth and Grand Canyon. The most extensive area is east of the Fraser River. These soils have developed on moderately calcareous, stratified silty clay and clay on gently sloping terraces. They are associated with the Longworth soils in the better-drained positions and with the Moxley and Aleza soils in depressions. They are permeable to air, moisture, and plant roots. Rainfall is readily absorbed and well retained. The water-holding capacity is moderately high.

The soils are medium acid, moderately well supplied with organic matter and plant nutrients.

The native vegetation is alpine fir, white birch, western thimbleberry, false hellebore, and bunchberry.

Hutton clay loam, a Bisequa Gray Wooded soil, is described as follows:

Horizon	*Depth Inches*	
F	1 – 0	Partially decomposed birch leaves.
Ae	0 – 2	Light gray (10YR 7/1 m) silt loam; coarse platy; friable; abrupt, wavy boundary; pH 6.0.
Bfh	2 – 3	Strong brown (7.5YR 5/6 m) silt loam; very friable; weak, fine granular; abrupt boundary; pH 5.8.
Bf	3 – 8	Yellowish brown (10YR 5/8 m) silt loam; weak, fine platy; abrupt boundary; pH 5.7.
Ae	8 – 12	Light olive brown (2.5Y 5/6 m) silt loam; platy; friable; pH 5.5.
Bt	12 – 28	Grayish brown (2.5Y 5/2 m) silty clay loam; moderate, fine subangular blocky; firm; abrupt boundary; pH at top 5.0, at bottom 5.2.
IIC	28 +	Pale yellow and yellow (10YR 6/4 and 8/6) sand; single grain; loose; pH 6.0.

Use. The Hutton soils are well suited to growing vegetables and forage crops. They are easily tilled and can be worked within a fairly wide range of moisture conditions. Soil and plant nutrients are easily conserved. The soils can be used intensively if management is good and organic matter and fertilizers are applied. Local climate may be a problem.

Of the 9,500 acres of Hutton soils mapped in the area, 2,800 acres are rated as Class 3 and 6,700 acres as Class 4.

Kiwa Series

The Kiwa soils occur in the Rocky Mountain Trench southeast of the Grand Canyon. They have developed on a very stony calcareous till that was deposited parallel to the mountain wall on both sides of the Trench. Below the elevation of 3,900 feet, the till is mantled by fine sediments. Long, narrow gravel beaches occur at an elevation of 3,900 ft.

The topography of the Kiwa soils is irregular, steeply sloping, and hilly. In some areas erosion has been severe and the till is mantled with slope wash and littered with very large boulders. The Kiwa soils are close to the mountain wall and are therefore often associated with the coarse colluvium on which the Tumbledick soils have developed.

These soils are well drained and have a low water-holding capacity. They are very strongly acid and moderately low in organic matter and plant nutrients. They are generally quite stony. The C horizon is weakly effervescent.

The vegetation is spruce, alpine fir, hemlock, and western red cedar.

Kiwa sandy loam, an Orthic Podzol, is described below:

Horizon	*Depth Inches*	
L – H	3 – 0	Raw and decomposed moss, evergreen needles, and twigs.
Ae	0 – 4	Light gray (10YR 7/1 m) very stony sandy loam; single grain; loose, friable; pH 4.2.
Bf	4 – 7	Reddish brown (5YR 4/3 – 4/4 m) exceedingly stony loamy sand; weak, fine granular; firm; pH 4.5.
BC	7 – 13	Dark brown (10YR 4/3 m) loam; weak, medium blocky; firm; pH 6.2.
C	13 +	Olive brown (2.5Y 4/4 m) loam; weak, medium pseudo-blocky; hard, compact; pH 7.4.

Use. There is no agricultural development on these soils. The steep topography and stoniness severely limit their use for agriculture. All 83,500 acres of Kiwa soils in the surveyed area are rated as Class 7.

Longworth Series

The Longworth soils have developed on noncalcareous sandy deposits on terraces of the Fraser River in an area that extends from the Grand Canyon to McBride. They usually occur as a complex with the Toneko soils. They occupy gentle and moderate slopes that are dissected by erosion channels and stream courses.

They are well-drained soils that have slow runoff, moderately rapid internal drainage, and low water-holding capacity. Air, moisture, and plant roots penetrate the soils easily. They are very strongly acid, moderately low in plant nutrients, and medium in organic matter content.

The vegetation is spruce, hemlock, and western red cedar. In the vicinity of Longworth these soils occur under stands of trembling aspen.

Longworth fine sandy loam, a Bisequa Podzol, is described as follows:

Horizon	*Depth Inches*	
L – F	2 – 0	Litter and partially decomposed moss, leaves, and spruce needles.
Ae	0 – 3	Grayish brown (10YR 5/2 m) fine sandy loam; weak, fine platy; friable; depth ranges from 2 to 4 inches; very strongly acid.
Bfh	3 – 5	Dark reddish brown (5YR 3/4 m) sandy loam; weak, fine granular; friable; very strongly acid.
Bf	5 – 8	Brown to dark brown (7.5YR 4/4 m) loam; weak, fine and medium blocky; friable; very strongly acid; diffuse, smooth boundary.
C	8 – 12	Yellowish brown (10YR 5/4 m) loam; weak, fine pseudo-blocky; firm; medium acid.
Bt	12 – 24	Brown (10YR 5/3 m) stratified fine sandy loam and loam; medium acid. From 12 to 16 inches depth the bands are moderate, fine subangular blocky loam and weak, fine subangular blocky to amorphous fine sandy loam; below 16 inches depth the loam bands are diffuse and farther apart in the fine sandy loam.

C	24 +	Dark brown to brown (10YR 4/3 m) fine sandy loam; few, fine, faint mottles at 48 inches depth; weak, coarse pseudo-platy; firm; slightly acid.

Use. In the mapped area a total of 29,000 acres of Longworth soils were mapped, of which 4,200 acres are rated as Class 3, 22,300 acres as Class 4, 1,100 acres as Class 5, and 1,400 acres as Class 7.

These soils are very easily worked when cleared. Potatoes and many kinds of vegetables do well as do pasture and forage crops. They need organic matter and fertilizer to maintain tilth.

Limitations are erosion on moderate slopes.

McGregor Series

The McGregor soils occur on all the recent alluvial deposits in the mapped area. The largest single area occurs in the McGregor pitted outwash plain at the confluence of the McGregor and Fraser rivers (Fig. 11). Extensive areas have been mapped adjacent to the Fraser River between Penny and McBride.

McGregor soils are young and their parent material has not been in place long enough to have developed well-defined horizons such as are present in the soils of the higher terrace and uplands. The McGregor soils are often inundated during periods

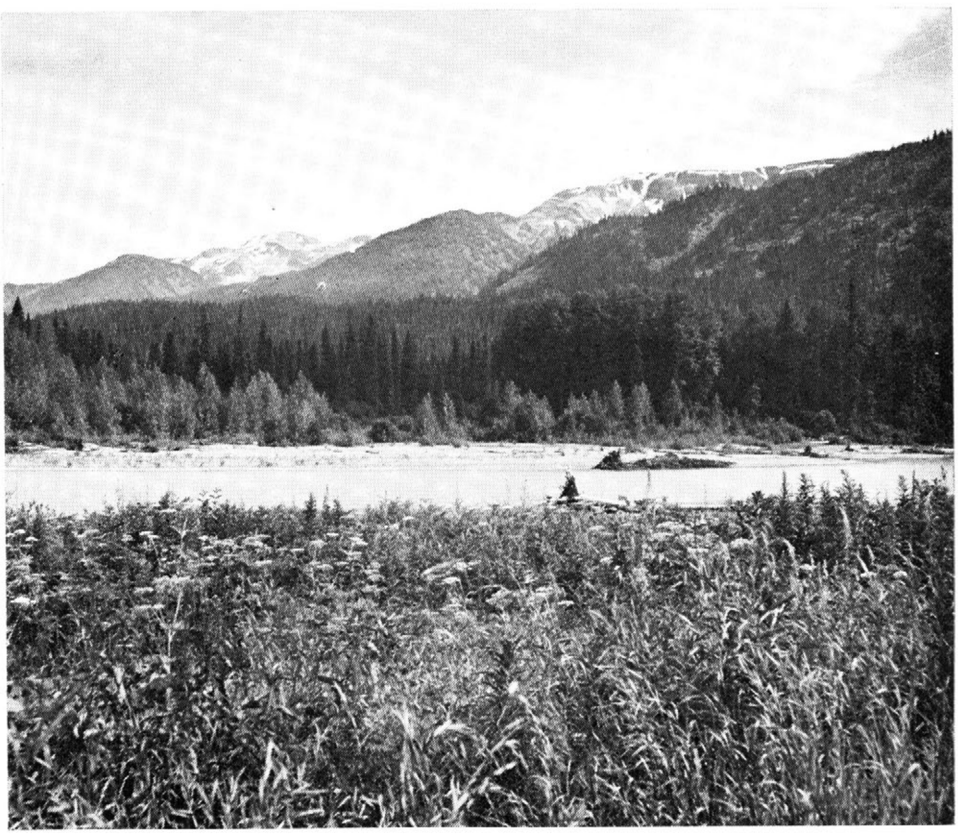


Fig. 11. McGregor sandy loam in the foreground, Toneko loamy sand on the higher terraces, and Tumbledick and Kiwa soils on the mountain slopes.

of flood or high water. Their topography is very gently sloping to gently sloping with some depressional sites.

The soils are neutral to mildly alkaline and moderately high in organic matter content and plant nutrients. They are imperfectly and moderately well drained and moisture, air, and plant roots penetrate the soil easily. Runoff is slow, internal drainage is moderately rapid, and the moisture holding capacity is low.

The vegetation is balsam, black cottonwood, and spruce. In a few areas mature western red cedar and a dense understory of devil's-club occur.

McGregor fine sandy loam, a Mull Regosol, is described as follows:

Horizon	*Depth Inches*	
L – F	2 – 0	Decomposing deciduous leaves, grass, and plant remains.
Ahk	0 – 3	Dark brown (10YR 4/3 m) fine sandy loam; fine and medium granular; very friable, loose; weakly effervescent.
Ck	3 – 38	Alternating layers 1 to 4 inches thick of dark gray and gray (10YR 4/1 and 5/1 m) fine sandy loam; amorphous; friable; strongly effervescent.
IICkgj	38 +	Yellowish brown (10YR 5/4 m) fine sand; many, coarse, distinct, brown mottles; single grain; weakly affervescent.

Use. In the mapped area 3,200 acres of McGregor soils are rated as Class 3, 8,800 acres as Class 4, 25,900 acres as Class 5, and 5,050 acres as Class 7. Class 2 soils occur in small unmappable units.

Very little acreage of McGregor soils has been cleared, probably because of the intermittently high water table and susceptibility to flooding and to frost. When cleared the soils are easily tilled and well suited to such crops as potatoes and to pasture.

Moxley Series

The Moxley soils are peats developed on accumulations of plant material that have remained excessively wet and without air for a long period of time. They occur throughout the mapped area. The largest section extends from Cornel Mills to Grand Canyon adjacent to the Fraser River.

These soils have depressional to level topography and are very poorly drained. They are very strongly to strongly acid in reaction. The depth of peat varies considerably.

The vegetation on the Moxley soils consists of Labrador tea, pale laurel, and peat moss, frequently with poorly developed black spruce or scrub birch.

Moxley peat described below represents the shallowest deposition of organic materials over mineral soil within this series.

Horizon	*Depth Inches*	
L	0 – 10	Raw sphagnum mosses.
F – H	10 – 16	Semidecomposed and decomposed mosses and woody materials; pH 4.7.
Cg1	16 – 24	Grayish brown (10YR 5/2 m) clay; many, prominent mottles; amorphous; plastic; pH 5.2.
Cg2	24 – 31	Grayish brown (10YR 5/2 m) clay; many, prominent, strong brown (7.5YR 5/8 m) mottles; amorphous; pH 5.7.

Use. At the present time the Moxley soils are considered unsuitable for agricultural use because of the raw nature and very strongly acid reaction of the upper layers of peat, the very poor drainage, and the great difficulty of clearing and cultivating them.

Pineview Series

The Pineview soils have developed on moderately calcareous stratified lacustrine clay and silt. They occur in the northern part of the mapped area in the Prince George laking basin. Much of this part is hilly and severe erosion channels are present in some localities.

Pineview soils are imperfectly drained and have medium runoff, slow internal drainage, and high water-holding capacity. They are medium to strongly acid, low in organic matter content, and moderately well supplied with bases.

These soils are frequently associated with the Aleza series.

The *Aralia* – oak fern site is the dominant forest site type on the Pineview soils. On knolls, better drainage conditions are reflected by the presence of a bunchberry – moss site type. On poorer drainage the devil's-club forest site type occurs.

Pineview clay, a Gleyed Gray Wooded soil (Fig. 6), is described as follows:

Horizon	*Depth Inches*	
L – H	2 – 0	Raw and decomposing needles, twigs, ferns, and mosses.
Aegj	0 – 3	Brown (10YR 5/3 m), very pale brown (10YR 7/3 d) loam; granular; friable; common, fine, faint yellowish brown mottles; pH 5.3.
ABg	3 - 8	Strong brown (7.5YR 5/6 m), very pale brown (10YR 7/4 d) clay loam; common, coarse, distinct mottles; medium to subangular blocky; plastic, friable; pH 5.8.
Btg	8 – 15	Brown (7.5YR 5/2 m), grayish brown (10YR 5/2 d) clay; many, coarse, distinct mottles; compound, coarse columar and coarse blocky; plastic; siliceous coating on the surface of peds; pH 6.0.
BCg	15 – 18	Grayish brown (10YR 5/2 m) clay; many, coarse, distinct, yellowish brown (10YR 5/4 m) mottles; amorphous with strong vertical cleavages; plastic; weak strata are distorted, folded, and broken; pH 6.5.
Cg	18 – 26	Dark brown (7.5YR 4/4 m) clay and olive (5Y 5/3 m) silt; common, gray mottles; silt strata are usually thinner than clay strata; coarse platy; pH 6.5.
IICg	26 +	Olive and gray (5Y 4/3 and 5/1 m) silt loam and silty clay loam; common, gray mottles; amorphous; pH 6.5.

Use. Most of the Pineview soils in the mapped area are under spruce – alpine fir forest or second growth vegetation. Out of a total of 99,100 acres, 26,000 acres are rated as suitable for arable agriculture (Class 4), 72,100 acres are classed as suitable only for producing perennial forage crops (Class 5), and 1,000 acres as Class 7.

When cleared, satisfactory yields of grain and forage can be obtained on the Pineview soils. The soils can be used intensively if good management is practiced and good levels of organic matter and fertility are maintained. Cultivation can only be done within a narrow moisture range in order to prevent puddling and compaction.

Imperfect drainage, undulating topography, erosion, and soil structure are factors that limit the agricultural use of these soils in many places.

Raush Series

The Raush soils occur near the village of McBride in the southern part of the mapped area and are associated with the Doré series. The most extensive portion, located on the west side of the Fraser River, has the most agricultural development.

These soils have developed on moderately calcareous stratified lacustrine clay and silt. They occur on gently and moderately sloping land, and are moderately well drained. Runoff is medium, internal drainage is slow, and the water-holding capacity is high.

The Raush soils are medium to strongly acid, low in organic matter, and well supplied with plant nutrients. Natural drainage is good enough not to be a limitation in these soils.

The dominant vegetation is trembling aspen, black cottonwood, and mountain alder.

Raush clay, an Orthic Gray Wooded soil (Fig. 6), is described as follows:

Horizon	*Depth Inches*	
L – F	2 – 0	Decomposing deciduous leaf and plant remains.
Ae	0 – 2	Light gray (2.5Y 7/2 m) loam; moderate, fine to medium platy; friable; pH 5.8.
AB	2 – 12	Light olive brown (2.5Y 5/4 m) ped surface, pale yellow and light gray (2.5Y 7/4 and 7/2 m) ped interior; clay loam; compound, weak, medium columnar and medium subangular blocky; hard; pH 5.3.
Bt	12 – 21	Dark brown (10YR 4/3 m) clay; compound, strong, medium columnar and strong, medium subangular blocky; hard; columns waxy and clay skins present; silica coatings dominant on upper surface of columns; pH 5.3.
BC	21 – 25	Dark brown (10YR 4/3 m) ped surface, dark brown and dark grayish brown (10YR 4/2 and 4/3 m) ped interior; clay; compound, weak, medium columnar and moderate, medium subangular blocky; hard; gradual, smooth boundary; pH 5.8.
CB	25 – 34	Gray to grayish brown (10YR 5/1 – 5/2 m) clay; few, fine, faint, yellowish brown (10YR 5/4 m) mottles; compound, weak, medium subangular blocky and weak, coarse platy; hard; pH 6.6.
C	34 – 48	Olive gray (5Y 5/2 m) stratified silt; with increasing depth strata are alternately light gray and pale yellow (5Y 7/2 and 7/4 m) silt and silty clay; pH 7.5.
Ck	48 +	Stratified silt and silty clay as above; strongly effervescent; in places cemented with lime.

Use. Out of 19,150 acres of Raush soils in the mapped area 7,150 acres are rated as Class 3, 850 acres as Class 4, and 11,150 acres as Class 5.

Much of the dairying and mixed farming in the McBride area is done on these soils. The soils are well suited to growing grains, forage, and pasture. The low organic matter content, the narrow moisture range in which the soils may be worked, and the susceptibility to erosion and compaction make good tilth difficult to maintain. The soils respond to good management, especially to adequate fertilization and proper rotation of crops.

Seebach Series

The Seebach soils have developed on noncalcareous coarse-textured glacial outwash and occur on a pitted outwash plain east of the Fraser River between Hansard and the McGregor River.

The plain has generally smooth topography and slopes toward the Fraser River. The relief is broken by large circular pits that may contain water.

The Seebach soils are well drained to moderately well drained and have very slow runoff, medium to rapid internal drainage, and low water-holding capacity. The presence of the ortstein horizon, while not continuous, is advantageous in these soils because it slows the downward movement of water and makes it available to plant roots for a long period of time in the spring.

These soils are very strongly to strongly acid and have a moderate organic matter content and very low supply of plant nutrients.

The dominant vegetation is spruce with some alpine fir. The understory is sparse, but a good growth of moss is present. The devil's – club forest site type is the most frequent type occurring on Seebach soils.

Seebach loamy sand, an Ortstein Podzol (Fig. 7), is described as follows:

Horizon	*Depth Inches*	
L – F	4 – 0.5	Semidecomposed moss, coniferous residue, and twigs.
H	0.5 – 0	Well-decomposed, very dark gray organic material.
Ae	0 – 3	Pinkish gray (5YR 7/2 m) loamy sand; single grain; pH 4.5.
Bf	3 – 5	Dark reddish brown (5YR 3/2 m) loamy sand; weak, fine subangular blocky; firm; pH 5.4.
Bfc	5 – 11	Dark reddish brown (5YR 3/3 m) loamy sand; strongly cemented but discontinuous; pH 6.0.
BC	11 – 16	Yellowish brown (10YR 5/6 m) loamy sand; single grain; firm, hard; pH 6.0.
C	16 – 32+	Light olive brown (2.5Y 5/6 m) loamy sand; single grain; pH 6.2.

Use. In the mapped area the Seebach soils occupy 36,500 acres, of which 24,300 acres are rated as Class 5 and 12,200 acres as Class 7.

These soils are all in forest. They are poorly suited to growing crops or pasture because of coarse texture, low fertility, and low moisture-holding capacity throughout the growing season.

Toneko Series

The Toneko soils have developed on noncalcareous, moderately coarse textured alluvium and occur on the upper terraces of the Fraser River in the area extending from the Grand Canyon to McBride (Fig. 11). They occur as a complex with the Longworth soils. Much of the terraced land surface in this section has been eroded by streams that enter the Rocky Mountain Trench from the east and west. Between the eroded channels and stream courses, the topography is moderately and steeply sloping.

These soils are well drained and have slow runoff, rapid internal drainage, and low water-holding capacity. They are strongly acid, and low in organic matter and plant nutrients.

The vegetation consists of spruce, hemlock, and western red cedar.

Toneko sandy loam, an Orthic Podzol (Fig. 7), is described as follows:

Horizon	*Depth Inches*	
L – F	2 – 0	Decomposing remains of fir and spruce needles, hellebore leaves, and bracken fern.
Ae	0 – 2	Light brownish gray (10YR 6/2 m) very fine sandy loam; weak, fine platy; friable; pH 5.0.
Bf	2 – 9	Yellowish brown (10YR 5/6 – 5/4 m) sandy loam; weak, fine subangular blocky; friable; pH 5.3.

BC	9 – 17	Light olive brown (2.5Y 5/4 m) very fine sandy loam; weak, fine subangular blocky; friable; pH 5.5.
C	17 – 37	Light olive brown (2.5Y 5/4 m) very fine loamy sand; very weakly stratified; intensely colored bands throughout horizon about 4 inches apart; pH 5.7.
IIC	37 +	Light olive brown and olive brown (2.5Y 5/6 and 4/4 m) medium to coarse sand; loose; contains considerable finely divided mica; pH 5.8.

Use. There are 146,900 acres of Toneko soils in the mapped area, of which 5,100 acres are rated as Class 3, 12,800 acres as Class 4, 70,500 acres as Class 5, and 58,500 as Class 7.

Most of these soils are under forest. Low fertility, low water-holding capacity, and steep topography limit the agricultural development on many areas of these soils.

Tumbledick Series

The Tumbledick soils occur on coarse-textured colluvial and alluvial materials that were deposited at the base of the mountain wall on either side of the Rocky Mountain Trench and the steep slopes of the uplands surrounding the northern lacustrine basin. In the latter location they are associated with soils of the Chilako complex. In the southern part of the Trench they are associated with the Eddy soils, which are developed on fine-textured colluvial materials. They are also associated with the Kiwa soils, particularly in sections where colluvium has mantled the glacial till.

The topography of the Tumbledick soils is irregular, very steeply sloping, and hilly. The land surface is littered with very large boulders.

The soils are well drained, and have slow runoff, rapid internal drainage, and low moisture-holding capacity. They are medium to strongly acid, low in organic matter content, and moderately low in plant nutrients.

The vegetation consists of hemlock, spruce alpine fir, and western red cedar.

Tumbledick stony loamy sand, an Orthic Regosol, is described as follows:

Horizon	*Depth Inches*	
L – F	2 – 0	Litter and semidecomposed remains of grass, leaves, and coniferous material.
C1	0 – 4	Light yellowish brown (2.5Y 6/4 m) sandy loam; weak, fine subangular blocky; loose; charcoal common; noncalcareous.
C2	4 – 6	Reddish brown (5YR 4/3 m) loamy sand; single grain; charcoal common; noncalcareous.
C3	6 +	Light yellowish brown (10YR 6/4 m) very stony loamy sand; single grain; noncalcareous.

Use. All 171,200 acres of Tumbledick soils in the mapped area are rated as Class 7. They are not considered suitable for agricultural development because of the steep topography and extreme stoniness.

Valemount Series

The Valemount soils have developed on outwash sands and extend from Tête Jaune southward to the base of Canoe Mountain and to the Camp Creek Valley. The village of Valemount is about the center of this section.

The outwash sands have been duned and where the vegetation has been disturbed the dunes are moving. The topography is level and moderately sloping.

These soils are rapidly drained and have a very low water-holding capacity.

They are medium acid, and are low in organic matter content and plant nutrients.

The vegetation is lodgepole pine with a ground cover of bearberry.

Valemount loamy sand, an Orthic Acid Brown Wooded soil, is described as follows:

Horizon	*Depth Inches*	
L	1 – 0	Litter of pine needles and bearberry.
Bm	0 – 5	Yellowish brown (10YR 5/4 – 5/6 m), light yellowish brown to brownish yellow (10YR 6/4 – 6/6 d) loamy sand; weak, very coarse granular to single grain; loose; pH 5.8.
C	5 – 14	Light yellowish brown (10YR 6/4 m), very pale brown (10YR 7/4 d) sand; single grain; loose; pH 6.0.
IIC	14 +	Pale brown (10YR 6/3 m), light gray (10YR 7/1 d) sand; single grain; firm; faintly mottled at 38-inch depth; pH 6.1.

Use. There are a total of 23,450 acres of Valemount soils in the mapped area, of which 2,300 acres are rated as Class 5 and 21,150 acres as Class 7.

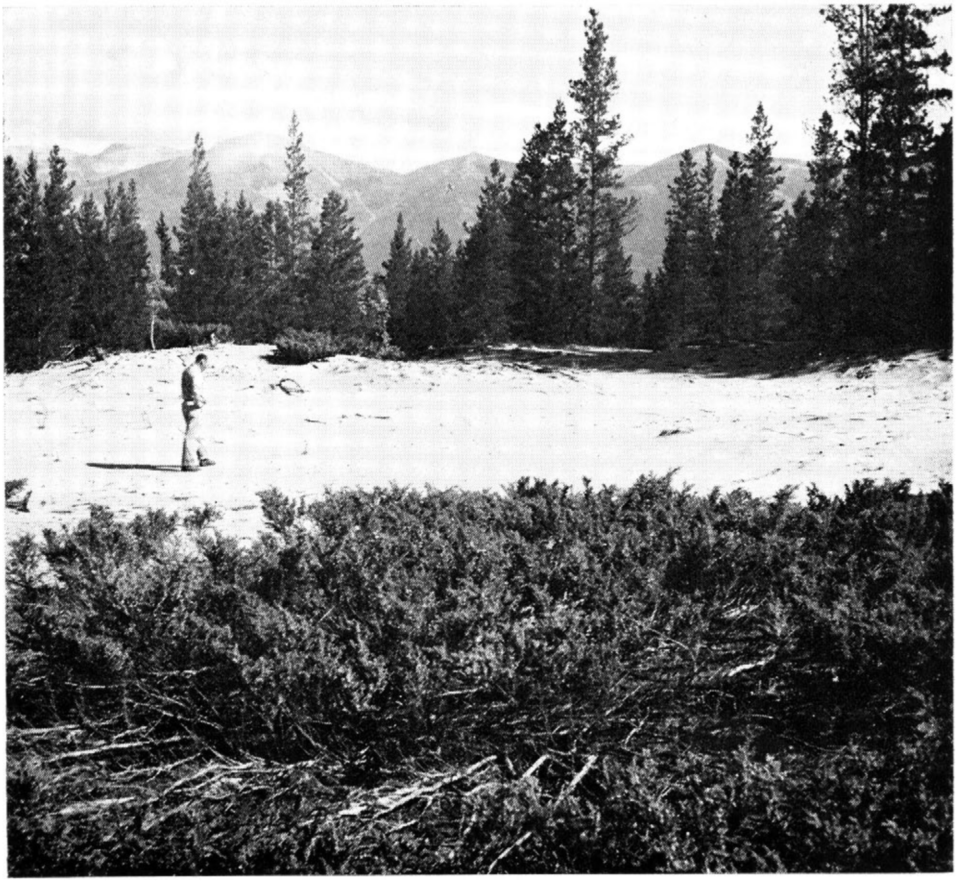


Fig. 12. Dune sands associated with the Valemount soils.

Many acres of Valemount soils are subject to drifting when the vegetation is removed. The lack of structure, low organic matter content, low fertility, and very low water-holding capacity severely limit their use for agriculture. They may be used for short periods for grazing.

Rough Broken Land

Rough broken land is a land type that covers 44,900 acres in the mapped area. It is used to delineate steep eroded banks along river channels.

Use. Rough broken land is unsuitable for agriculture.

SOIL CAPABILITY CLASSIFICATION

The mineral soils of the upper part of the Fraser Valley are grouped into capability classes (Table 7) according to their potentialities and limitations for agricultural use. Classes 1, 2, 3, and 4 are capable of sustained production of common cultivated crops. Class 5 is suitable only for permanent pasture and hay, and Class 6 is capable of use only for unimproved pasture. Class 7 is considered incapable of use for arable agriculture or pasture. Soil areas in all classes may be suited for other purposes such as forestry, wildlife, or recreation.

Soils of the surveyed area belong in Classes 3, 4, 5, and 7. Climatic restrictions eliminate Class 1 soils, and soils of Class 2 are confined to small unmappable areas in the Willow Valley and near the village of McBride. No Class 6 soils were recognized in the area. Soil factors of structure and permeability, erosion, low native fertility, droughtiness, stoniness, slope and wetness, flood hazard, and depth to bedrock are limitations applied singly or in combination to soils of the area. Organic soils are not included in this capability classification.

Of the 23 soil series, soil complexes, and land types mapped in the upper part of the Fraser Valley, less than 18% are capable of sustained arable culture.

The soils within a capability class are similar only with respect to degree but not to kind of limitations for agricultural purposes or hazard to the soil when it is so used. Each class includes many different kinds of soils and many of the soils within any one class require different management and treatment. The presence of forest cover was not considered a limitation.

The distance to markets, the presence of roads, location, size of farms, characteristics of landownership, and the skill or resources of individual operators are not criteria used in this capability classification.

Capability Class 1

Because of regional climatic limitations in the upper Fraser Valley, no soils were placed in this class.

Capability Class 2

Soils of this class have no limitations except climate. The soils are moderately high to high in productivity for a fairly wide range of field crops adapted to the region. In the surveyed area, a very limited acreage of soils of the Fraser soil complex and McGregor and Raush series belongs in this class. These soils are fertile and well drained, and occur on gentle to moderate slopes.

Because no soils of this class predominate in a mapping unit, no percentage figures are given.

Capability Class 3

Soils of Class 3 have moderately severe limitations that reduce the choice of crops. Soils of the Toneko series and Fraser complex belonging to this class are adversely affected by low moisture-holding capacity. The McGregor soils are subjected to frequent river overflow with some crop damage. The Aleza soils have a continuing limitation resulting from seepage or runoff. Soils of the Eddy, Hutton, Raush and Longworth series are affected by adverse soil structure and permeability. Minor cumulative effects of excess water and soil structure place some soils of the Bowron and Eaglet series in this class.

About 4% of the oils of the area belong in Class 3.

Capability Class 4

Soils of this class have severe limitations that restrict the choice of crops and require special conservation practices and careful management. The risk of crop failure is high.

The main limitation of Bednesti, Eena, and Pineview soils of this class is topography with slopes up to 15%. Excess water in the form of seepage, runoff, or poor soil drainage is an important limitation in Aleza, Doré, and Bowron soils. The remaining soils of this class, Eddy, McGregor, Hutton, Raush, Longworth, Toneko, and Fraser complex, are limited by structurally undesirable subsoil, low moisture-holding capacity, or irregular topography.

About 14% of the soils of the area belong in this class.

Capability Class 5

Soils of this class have very severe limitations that restrict their capacity to producing perennial forage crops. Improvement practices are feasible.

Steep slopes to 30% are the main limitation for Bednesti, Gunniza, Longworth, Pineview, Raush, and Toneko soils. Droughtiness is an adverse factor in the Eddy, Eena, Seebach, and Valemount soils of this class. McGregor and Aleza soils of Class 5 are subjected to very frequent overflow by rivers or lakes. The other soils belonging in this class, Bowron and Doré series, are very severely limited by excess seepage water or high water table.

About 25% of the soils in the area belong in this class.

Capability Class 6

No soils of the upper part of the Fraser Valley were placed in this class. Soils of Class 6 are capable only of producing perennial forage crops and improvement practices are not feasible.

Capability Class 7

Class 7 soils are considered to have limitations so severe that they are incapable of use for arable culture or permanent pasture. Limitations of slopes exceeding 30%, excessively stony land, and elevation restrict the Kiwa and Tumbledick soils and soils of the Chilako complex to this class. No section in which the Eaglet, Eddy, Hutton, and Raush soils predominate were placed in Class 7. Some sections of Aleza soils that are inundated for most of the growth period were considered to have no capability for arable agriculture or permanent pasture. The other soils in this class are restricted by extreme limitations of climate, topography, erosion, stoniness, wetness, or shallowness to bedrock. Rough broken land and eroded riverbanks are also included in Class 7.

More than 53% of the soils of the area belong in this class.

Organic soils, represented in the area by Moxley series, are not considered in this capability classification and the acreage is shown separately in Table 7.

Table 7. Soil Capability Classes and Acreage of Soils in the Surveyed area

Soil or land type	Class 3	Class 4	Class 5	Class 7	Organic soils	Acres in each soil or land type
Aleza	920	10,540	1,940	1,400		14,800
Bednesti		15,200	3,250	14,400		32,850
Bowron	3,280	14,600	17,900	920		36,700
Chilako				83,500		83,500
Doré		4,500	400	700		5,600
Eaglet	2,700					2,700
Eddy	300	6,800	6,300			13,400
Eena		1,900	2,200	850		4,950
Fraser	8,450	500				8,950
Giscome				200		200
Gunniza			2,700	6,600		9,300
Hutton	2,800	6,700				9,500
Kiwa				83,500		83,500
Longworth	4,200	22,300	1,100	1,400		29,000
McGregor	3,200	8,800	25,900	5,050		42,950
Moxley					34,000	34,000
Pineview		26,000	72,100	1,000		99,100
Raush	7,150	850	11,150			19,150
Seebach			24,300	12,200		36,500
Toneko	5,100	12,800	70,500	58,500		146,900
Tumbledick				171,200		171,200
Valemount			2,300	21,150		23,450
Rough broken land				44,900		44,900
Total acres in each class	38,100	131,490	242,040	507,470	34,000	953,100
Percentage of total area of soil	4.0	13.8	25.4	53.2	3.6	100.0
Lakes and rivers						3,050
Total acreage of surveyed area						956,150

ANALYSES OF SOIL SAMPLES

Chemical and physical analyses for certain soils occurring in the upper part of the Fraser Valley are reported in Table 8. The analyses support the opinion that the dominant soil-forming processes in the area are podzolization and gleysation. The soil characteristics resulting from these processes are discussed below.

Mechanical Analyses

The mechanical analyses (6) show an increase in clay content in most B horizons. The increase is most pronounced in the Bt of Gray Wooded soils and less pronounced in the Bf of Podzolic soil. The Gleysolic soils show an increase in clay in the B horizon.

pH

Most of the soils analyzed have acid upper horizons. The Gray Wooded soils usually have a reaction between pH 5.0 and pH 6.0 in the Ae and AB horizons. pH tends to approach neutrality (pH 7) with increasing soil depth. The Podzolic soils have strongly acid (pH 4.5 – 5.0) Ae horizons; the B and C horizons are usually medium or slightly acid (pH 5.6 – 6.5). The pH of Aleza, a Gleysolic soil, is slightly acid throughout the A and B horizons.

Organic Matter

The well-drained Podzolic soils in the surveyed area have low amounts of organic matter (8). There may be a slight increase in the organic matter content of the Bt horizon of Gray Wooded soils. Orthic Podzols and Bisequa Podzols have an increase in organic matter in the B horizons, which is usually associated with an increase in the Fe content. The Gleysolic soils have a high content of organic matter in the Ah horizon and soluble organic constituents appear to move downwards.

Cation-Exchange Capacity and Exchangeable Cations

The cation-exchange capacity (8) of a soil usually increases as the contents of organic matter and clay increase. In the Gray Wooded soils the clay content increases in the Bt horizon, whereas in Podzol and Bisequa Podzol soils, the organic matter content increases in the Bf or Bfh horizons. The exchange capacity is low in the Ae horizons because of the eluviation of organic matter and clay. The exchange capacity of the Gleysolic soils follows the high organic matter and clay content of the surface horizon.

The exchangeable cations (8) show that the exchange complex of the Gray Wooded soils is saturated dominantly with Ca and Mg. Usually the content of these cations increases with depth. The coarse-textured Podzol and Bisequa Podzol soils have a low exchange capacity. The mineral horizons of the Gleysolic soils have dominantly Ca and Mg on the exchange complex.

GLOSSARY

alluvium. A general term for all deposits of modern rivers and streams.

available nutrient. The portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants. (Available is different from exchangeable.)

boulders. Rock fragments over 2 ft in diameter.

bulk density. The weight of ovendry soil (105 C) in grams per unit bulk volume. The bulk volume is measured in cubic centimeters at field moisture conditions.

calcareous soil. Soil containing sufficient $CaCO_3$ (often with $MgCO_3$) to effervesce visibly when treated with cold 0.1 N HCl.

cation-exchange capacity. The total exchangeable cations that a soil can adsorb expressed in milliequivalents per 100 g of soil or of other adsorbing material such as clay. This is sometimes called "total-exchange capacity," "base-exchange capacity," or "cation-adsorption capacity."

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. See *texture.*

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.

cobblestone. Rounded or partially rounded rock or mineral fragments between 3 and 10 inches in diameter.

colluvium. A heterogenous mixture of material that has moved down a slope and settled at its base. See *creep.*

color. See *Munsell color system.*

complex, soil. See *soil complex.*

consistence. (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 consistence 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, and very firm.
- dry soil—loose, soft, slightly hard, hard, very hard, and extremely hard.
- cementation—weakly cemented, strongly cemented, and indurated.

creep. Slow mass movement of soil and soil material down relatively steep slopes primarily under the influence of gravity, but facilitated by saturation with water and by alternate freezing and thawing.

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 a river. Where the stream current reaches quiet water, the bulk of the coarses load is dropped and the finer material is carried farther out. Deltas are recognized by nearly horizontal beds termed bottomset beds overlain with more steeply inclined and coarser-textured beds called foreset beds.

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.

eluvial horizon. A soil horizon from which soil material has been removed in suspension or in solution. See *illuvial horizon.*

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, or kame terraces.

glacial till. Unsorted and unstratified materials deposited by glacial ice.

gravel. Rock fragments from 2 mm to 3 inches in diameter.

hue. One of the three variables of color. It is caused by light of certain wavelengths and it changes with the wavelength. See *Munsell color system, chroma,* and *value, color.*

illuvial horizon. A soil horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. It is the layer of accumulation. See *eluvial horizon.*

lacustrine deposit. Material deposited in lake water and later exposed either by the lowering of the water level or by the elevating of the land. These deposits range in texture from sands to clays.

leaching. The removal from the soil of materials in solution.

mottles. Spots or blotches of different color or shades of color interspersed with the dominant color.

muck. Highly decomposed organic material in which the original plant parts are not recognizable. It contains more mineral matter and is usually darker in color than peat. See *muck soil* and *peat.*

muck soil. An organic soil containing highly decomposed materials. Mucky peat and peaty muck are used to describe increasing stages of decomposition between peat and muck.

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 a hue of 10YR, a value of 6, and a chroma of 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 in the *System of Soil Classification for Canada.* The orders are Chernozemic, Solonetzic, Luvisolic, Podzolic, Brunisolic, Regosolic, Gleysolic, and Organic. All the soils in an order have one or more basic characteristics in common.

organic. An order of soils developed dominantly from organic deposits that are saturated for most of the year, or artificially drained, and that contain 30% or more organic matter to:

a) a depth of 24 inches (60 cm) if the surface layer consists dominantly of fibric moss, or
b) a depth of more than 16 inches (40 cm) for other kinds or mixed kinds of organic material, or
c) a lithic contact at depths greater than 4 inches (10 cm) but shallower than that specified in either a or b, or
d) a depth of 11 inches (25 cm) below the surface of a permafrost layer but shallower than either a or b.

ortstein. An indurated layer in the B horizon of Podzolic soils in which the cementing material consists of illuviated sesquioxides and organic matter.

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. Because different soil horizons vary in permeability, the particular horizons being studied should be designated. (ii) The property of a porous medium 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 – water ratio, and expressed in terms of the pH scale.

profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

reaction, soil. The degree of acidity or alkalinity of a soil, which is usually expressed as a pH value. Descriptive terms commonly associated with certain ranges in pH are: extremely acid, 4.5; very strongly acid, 4.5 – 5.0; strongly acid, 5.1 – 5.5; moderately acid, 5.6 – 6.0; slightly acid, 6.1 – 6.5; neutral, 6.6 – 7.3; slightly alkaline, 7.4 – 7.8; moderately alkaline, 7.9 – 8.4; strongly alkaline, 8.5 – 9.9; and very strongly alkaline, 9.1.

sand. (i) A soil particle between 0.05 and 2.0 mm in diameter. (ii) Any one of very coarse sand, coarse sand, medium sand, fine sand, and very fine sand. See *soil separates.* (iii) A soil texture class.

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; it differs from adjacent genetically related layers in properties such as color, structure, texture, and consistence, and 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.*

Organic layers contain more than 30% organic matter. Two groups of these layers are recognized:

O—An organic layer developed under poorly drained conditions and that is often peaty.

Of—The least decomposed kind of O layer. It contains large amounts of well-preserved fiber.

Om—An intermediately decomposed O layer containing less fiber than an Of layer.

Oh—The most decomposed O layer. This humic layer contains little raw fiber.

L. F, and H—These are organic layers developed under imperfectly to well-drained conditions and they are often composed of forest litter.

L—The original structures of the organic material are easily recognizable.

F—The accumulated organic material is partly decomposed.

H—The original structures of the organic material are unrecognizable.

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:

1. An enrichment in silicate clay, iron, aluminum, or humus.
2. A prismatic or columnar structure that exhibits pronounced coatings or stainings associated with significant amounts of exchangeable sodium.
3. An alteration of 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—Underlaying 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, etc.

Lower case 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 and 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—from 5 to 10% organic matter.

Bhf—greater than 10% organic matter.

g — A horizon characterized by gray colors or prominent mottling or both, indicative of permanent or periodic intense reduction, e.g., 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, g, n, and t to denote an expression of but failure to meet the specified limits of the suffix it modifies, e.g., 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 them 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 indiciated 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 higher ratio of fine (0.2 micron) to total clay than the IC horizon.

x — A horizon of fragipan character.

z — A permanently frozen layer.

soil reaction. See *reaction, soil,* and *pH, soil.*

soil separates. Mineral particles less than 2.0 mm in equivalent diameter and ranging between specified size limits. The names and size limits of separates recognized in Canada and the United States are: very coarse sand, 2.0 to 1.0 mm; coarse sand, 1.0 to 0.5 mm; medium sand, 0.5 to 0.25 mm; fine sand, 0.25 to 0.10 mm; very fine sand, 0.10 to 0.05 mm; silt, 0.05 to 0.002 mm; and clay, 0.002 mm.

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 and 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.

stones. Rock fragments over 10 inches in diameter if rounded and over 15 inches along the greater axis if flat.

terrace. A nearly level, usually narrow, plain bordering a river, lake, or the sea. Rivers sometimes are bordered by a number of terraces at different levels. There are also man-made terraces.

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 mm 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.

value, color. The relative lightness or 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. Because 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.

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Table 8. The Mechanical Composition and Chemical Properties of Some Representative soils

Horizon	Depth inches	Particle size			pH	Exchangeable cations meg./100 g soil					Organic matter
		Sand %	Silt %	Clay %		Ca	Mg	K	Na	Total	%
					Aleza Series, Low Humic Eluviated Gleysol						
L – F	2 – 0				6.0	42.6	26.4	0.66	0.43		
Ah	0 – 2				5.9	24.4	10.1	0.29	0.25	49.8	7.25
Aeg	2 – 5				6.0	13.7	6.8	0.16	0.22	27.0	1.82
Btg	5 – 14				6.0	13.3	7.3	0.16	0.25	21.6	1.14
Cg1	14 – 24				6.0	13.2	7.4	0.13	0.30	27.6	1.56
Cg2	24 +				5.3	8.1	7.8	0.21	0.20	23.9	
					Bednesti Series, Bisequa Gray Wooded						
Ae	0 – 4	15.6	67.0	17.4	6.1	10.1	0.8	0.18	0.11	14.2	3.04
Bf	4 – 10	15.4	59.3	25.3	6.5	15.5	0.8	0.13	0.19	21.7	3.58
Ae	10 – 14	13.3	58.0	28.7	6.8	16.1	1.3	0.13	0.18	19.2	1.06
Btl	14 – 18	6.5	70.9	22.6	7.0	18.0	1.8	0.13	0.21	20.6	
					Chilako Complex, Bisequa Gray Wooded						
Ae	0 – 4				4.5	2.02	0.92	0.05	0.05	18.28	3.50
Bfh	4 – 9				4.8	4.32	0.43	0.12	0.06	41.52	6.01
Bt	9 – 12				5.0	1.12	0.70	0.08	0.05	20.40	0.59
BC	12 – 24				6.0	4.93	2.14	0.08	0.16	9.30	0.35
C	24 +				6.8	6.88	2.96	0.09	0.20	9.29	0.45
					Doré Series, Gleyed Dark Gray Wooded						
F	3 – 0				6.5	82.87	17.12	0.88	0.52		
Ah	0 – 2				6.5	54.16	16.17	0.57	0.39	95.50	29.80
Aegj	2 – 5	12.0	21.9	66.1	6.5	21.57	6.63	0.33	0.12	33.26	2.30
Btg1	5 – 12	8.7	8.1	83.2	6.6	26.18	15.62	0.20	0.35	46.67	0.83
Btg2	12 – 17	7.7	4.3	88.0	6.4	27.35	14.94	0.20	0.47	47.72	0.11
Cg	17 +	3.3	11.6	85.1	8.3	33.45	9.55	0.22	0.49	33.46	

Table 8. The Mechanical Composition and Chemical Properties of Some Representative soils — *Continued*

Horizon	Depth inches	Particle size				Exchangeable cations meq./100 g soil					Organic matter
		Sand %	Silt %	Clay %	pH	Ca	Mg	K	Na	Total	%
					Eddy Series, Orthic Gray Wooded						
Ae	0 – 4				6.2	2.96	0.81	0.09	0.03	4.73	1.14
Bt	4 – 9				6.0	3.62	0.95	0.08	0.03	6.75	1.32
BC	9 – 15				6.5	1.32	1.21	0.05		2.40	0.57
C	15 – 55				6.5	1.04	1.87	0.06		1.83	0.25
IIC	55 +				7.0	2.20	1.18	0.06	0.12	3.10	0.78
					Eena Series, Orthic Podzol						
Ae	0 – 2				4.7	1.95	0.78	0.13	0.03	8.30	1.07
Bf	2 – 5				5.5	2.51	1.38	0.25	0.04	21.09	3.06
BC	5 – 9				6.3	1.07	2.12	0.14	0.03	8.66	0.72
IIC	9 – 15				6.2	7.68	4.47	0.12	0.15	14.88	0.27
IIIC	15 – 19				6.4	4.20	2.82	0.07	0.09	8.18	0.14
IVC	19 – 22				6.1	7.06	4.44	0.12	0.11	12.74	0.15
VC	22 – 31				6.4	4.11	2.70	0.08	0.08	7.80	
VIC	38 +				6.4	7.41	6.39	0.09	0.34	15.49	
					Longworth Series, Bisequa Podzol						
Ae	0 – 2				4.6	0.85	0.47	0.10	0.02	17.34	2.06
Bfh	2 – 3				4.5	1.87	1.32	0.10	0.07	28.27	6.34
Bf	3 – 6				5.3	0.11	0.33	0.11		20.81	6.05
C	6 – 10				5.7		0.32	0.04		6.62	0.10
Bt	10 – 32				5.5	0.35	0.48	0.10		5.55	0.30
C	32 +				6.0	1.13	0.57	0.09		4.57	0.22
					Pineview Series, Gleyed Gray Wooded						
Aegj	0 – 3	21.8	53.2	25.0	4.9	1.8	1.5	0.22	0.13	14.9	1.52
ABg	3 – 8	8.0	41.9	50.1	5.1	5.8	3.3	0.30	0.14	20.2	0.59
Btg	8 – 15	14.8	20.9	64.3	5.1	13.1	6.6	0.16	0.22	32.9	0.22
BCg	15 – 18	16.3	23.9	59.8	5.6	17.5	7.9	0.51	0.28	33.7	0.36
Cg	18 – 26	13.3	23.4	63.3	6.1	18.9	10.6	0.25	0.32	41.7	
IICg	26 +	4.8	39.9	55.3	6.5	9.4	4.0	0.17	0.20	15.6	

Table 8. The Mechanical Composition and Chemical Properties of Some Representative soils — *Continued*

Horizon	Depth inches	Particle size				Exchangeable cations meg./100 g soil					Organic matter
		Sand %	Silt %	Clay %	pH	Ca	Mg	K	Na	Total	%
					Raush Series, Orthic Gray Wooded						
Ae	0 – 2	10.0	38.2	51.8	5.8	11.80	3.50	0.28	0.07	17.69	
AB	2 – 12	4.0	27.1	68.9	5.3	11.10	6.44	0.23	0.09	23.53	1.14
Bt	12 – 21	7.1	16.3	76.6	5.3	15.32	9.50	0.28	0.21	30.48	0.74
BC	21 – 25	4.0	23.5	72.5	5.8	15.71	8.84	0.28	0.23	30.91	0.66
CB	25 – 34	3.2	30.3	66.5	6.6	13.81	8.40	0.28	0.27	25.78	
C	34 – 48	1.6	46.6	51.8	7.5	10.46	5.37	0.19	0.19	17.58	
					Seebach Series, Ortstein Podzol						
Ae	0 – 3	72.6	21.8	5.6	4.1	0.28	0.14	0.04	0.04	3.74	0.51
Bf	3 – 5	84.8	8.5	6.7	4.5		0.42	0.08	0.02	12.64	3.08
Bfc	5 – 7	87.1	8.7	4.2	5.2	0.26	0.30	0.04	0.03	8.48	1.74
BC	7 – 12	90.0	6.2	3.8	5.4	0.42	0.50	0.02	0.02	3.82	0.99
C	48 +	90.4	7.4	2.2	5.4	0.10	0.08		0.01	1.30	
					Toneko Series, Orthic Podzol						
Ae	0 – 2	22.2	55.4	22.4	5.0	1.68	1.04	0.81	0.04	11.18	
Bf	2 – 9	12.1	58.8	29.1	5.3	0.40	0.76	0.05	0.04	17.30	
BC	9 – 17	5.4	63.5	31.1	5.5	0.17	0.31	0.03	0.04	12.24	
C	17 – 37	20.4	68.9	10.7	5.7	0.16	0.11	0.02	0.03	4.60	
IIC	37 +	98.6	0.8	0.6	5.8	0.08	0.07		0.02	1.36	