SOIL SURVEY

of the

UPPER KOOTENAY AND ELK RIVER VALLEYS

in the

EAST KOOTENAY DISTRICT OF BRITISH COLUMBIA

by

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Soil Survey

The British Columbia Department of Agriculture in Co-operation with the Experimental Farms Service, Canada Department of Agriculture.

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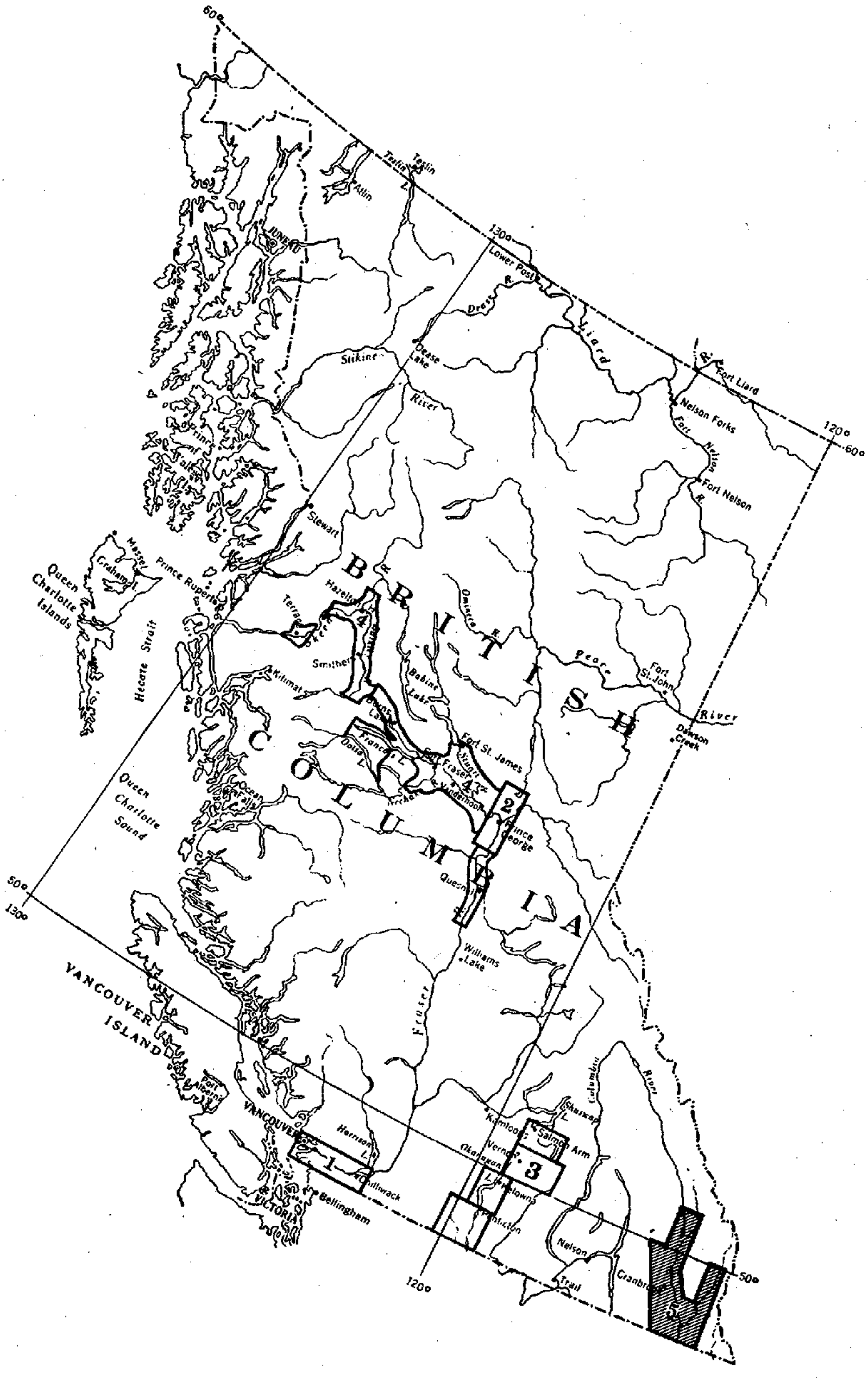

Map of British Columbia showing locations of surveyed areas for which reports and maps have been published. (1) Lower Fraser valley (2) Prince George Area (3) Okanagan and Similkameen valleys (4) Quesnel, Nechako, Francois Lake and Bulkley-Terrace Areas (5) Upper Kootenay and Elk River valleys.

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INTRODUCTION

The British Columbia Soil Survey is a co-operative undertaking. The Provincial Department of Agriculture, the Experimental Farms Service, Canada Department of Agriculture and the Department of Soil Science, University of British Columbia, participate in the survey projects. Each report, complete in itself, contains a brief description of the surveyed area. While presentation of soils information is the primary purpose, the report includes other data bearing on the nature of the soils and their utilization.

The classified area is in a pioneer stage of development and the climate is summer-dry. Very little land is suitable for farming without irrigation. While full development of irrigated agriculture may not take place for some time, it was necessary to establish a prior right to water for the irrigable land from the supply in the Kootenay River Basin. The soils information for this purpose was obtained by a survey of soils according to their suitability for irrigation, combined with a detailed reconnaissance soil survey. The results of the soil survey are given in this report. The water requirements of the potentially irrigible soil types were estimated by the Department of Agriculture Reclamation Committee and reported elsewhere.*

As indicated in Table 4, the Upper Kootenay and Elk River valleys contain relatively large areas of land suitable for agricultural development, but most of this land requires high cost reclamation. As of 1955 the land under irrigation is limited to a comparatively small acreage by scarcity of water supplies that can be developed at low cost.

Taken as a whole the mapped area has many resources. Minerals, timber and game occur in the surrounding Purcells and Rocky Mountains, which also have outstanding scenery. The tourist traffic is important, and the climate is appreciated for its dry summers and clear atmosphere. While the agriculture is not well developed, great possibilities exist for future expansion.

Six soil maps accompany this report. The maps cover about 70 miles of the Elk River valley, the Rocky Mountain Trench between the border of Montana and Canal Flats, and the Kootenay River valley from Canal Flats to the boundary of the Kootenay National Park. The map scale is one inch to one mile. The soils located on the maps are differentiated by symbols and colors, which are explained in the legend.

* See footnote, page 88.

GENERAL DESCRIPTION OF THE AREA

Location and Extent

The mapped area lies in the southeast corner of British Columbia. It begins in the Upper Kootenay River valley at the National Park boundary directly east of Radium, the latitude being about 50° 37″ and longitude 115° 40″. From this point it extends downstream in a southwesterly direction to Canal Flats, where the Kootenay River enters the Rocky Mountain Trench. From Canal Flats at 50° 09″ north latitude, the map-area extends southward in the Rocky Mountain Trench between 115° 54″ and 115° 41″ north longitude. The southern boundary is on the 49th parallel between 115° 22″ and 115° 06″ longitude. The mapped area also includes the Elk River valley from a point almost east of Canal Flats at 50° 06″ latitude, 114° 56″ longitude extending to Elko at 49° 18″ latitude, 115° 06″ longitude.

The surveyed area covers approximately 875,000 acres. In this total there are about 852,000 acres of land and 23,000 acres of lakes and rivers.

History and Development

The first white man to enter the East Kootenay district was David Thompson. Seeking new territory for the North West Fur Company, he left Rocky Mountain House, Alberta, in 1807. After ascending the North Saskatchewan and Howse rivers, he crossed the Howse Pass and descended the Blaeberry River to its junction with the Columbia, about 10 miles north of Golden. In 1807 the trading post "Kootenae House" was built in the vicinity of Athalmer. MacGillivray's River (the Kootenay River) was explored in 1808, and for the next 50 years the chief interest of the white man in the region was centered in the fur trade.

The second stage of development had its source in the California gold rush of the 1840's, which concentrated a large population of prospectors. As opportunities declined in California the prospectors moved northward. A few who travelled overland followed the Kootenay River. A party found gold in Findlay Creek in 1862, but had to leave the country for the winter. On returning in 1863 they discovered a richer placer in Wild Horse Creek. Placer mining in the district continued with varying degrees of intensity until the time of railway construction, which had the effect of diverting attention to lode mining and lumbering. Between 1890 and 1895 the North Star, Stemwinder, St. Eugene, Sullivan and other mining prospects were staked. The first ore, from the North Star mine, was taken by river to Jennings, Montana, and shipped by railway for smelting at Everett, Washington.

The first pre-emptions were located around 1867. Some of these were in the vicinity of placer claims, but they were chiefly along the St. Mary River. The early claims had to be recorded at Lytton, the delay being from two to four months. The first records issued at Fort Steele date from 1872.

In the days of the gold rush some of the early drives of beef cattle for meat were brought over the Beef Trail from the West Kootenay district. The route was from Argenta to Windermere over the Earl Gray Pass. Before 1890 several local ranchers had herds of from 200 to 300 head of beef cattle. In 1910 the first sheep were brought from California to Bummers Flats, which is now an Indian Reserve.

As in most pioneer localities very few settlers were able to devote their whole time to the development of a homestead. While the farm or ranch served as a home, outside employment was the chief source of income, until livestock gradually increased in number and value.

Towns, Population and Industries

The boom town associated with the Wild Horse Creek gold strike was first called Wild Horse. From the late 60's to 1886 it was known as Galbraith's Ferry after R. L. T. Galbraith, who ran a ferry across the Kootenay River near the present location of the Fort Steele bridge. Galbraith's Ferry became known as Fort Steele in 1888, after Col. Sam Steele arrived with a detachment of mounted police from Fort MacLeod, Alta. The decline of this community followed construction of the Crowsnest Pass Railway in 1898, which neglected Fort Steele in favor of Joseph's Prairie (Cranbrook). Cranbrook was incorporated as a city in 1905.

The railway and lumber industry have been the chief sources of employment. The tourist traffic is an important source of income in summer. American cars crossing the border at Kingsgate and heading through Cranbrook amount to about 30,000 per annum. Recent improvement of transportation permits extension of local employment to the Kimberley area. The population of Cranbrook was 3,800 in 1954.

Kimberley's existence is tied to the Sullivan Mine, the greatest lead-zinc mine in the world, and a fertilizer plant. The first settlement was in 1892 and was known as Mark Creek Crossing. In 1896 it was renamed Kimberley after Kimberley in South Africa. Kimberley was incorporated as a city in 1944, the population being 6,100 in 1954.

The rural population between Canal Flats and the International Border is estimated at about 2,045, and there are 500 more rural people in the Elk River valley.

There are six Indian Reserves in the Upper Kootenay Valley. St. Mary's Indian Reserve No. 1 covers 17,425 acres between St. Mary's Prairie and the mouth of St. Mary River, and Indian Reserve No. 1A, 25·05 acres, is occupied by the Indian village at St. Eugene Mission. Indian Reserve No. 4, Isidore Ranch, consists of 680 acres on the Kootenay River to the east of Rampart. Cassi-Mayook Indian Reserve No. 5, 155·94 acres, lies about half a mile north of Mayook Siding. Bummers Flats Indian Reserve No. 6 lies about three miles north of Fort Steele on the Kootenay River and occupies 190 acres. These reserves have a population of 187. In addition there is the Tobacco Plains Indian Reserve No. 2, Flagstone P.O., with an area of 10,521·43 acres and a population of 68.

In the Rocky Mountain Trench, between Canal Flats and Montana, regeneration is slow and tree growth is more or less open. On the heavier, more moisture-retentive soils, the conditions are suitable for Christmas tree production, and the annual Christmas tree crop has become a source of revenue for farmers and others. The trees are cut so that they will grow again.

The tree cutting begins in October, the trees being graded, tied in bundles and shipped in car lots. The number of trees in a bundle varies with the length of the tree. There are eight two- to three-foot trees, six three- to four-foot trees, four five- to six-foot trees, three seven- to eight-foot trees, two nine- to ten-foot trees and one tree twelve feet or more to a bundle. The annual cut and its value f.o.b. for nine years is as follows:—*

Year	Number of trees	Total value	Price paid to the farmer
		$	$
1946	600,200	138,046	0·40 per bundle
1947	381,500	64,855	0·40
1948	580,000	116,000	0·90
1949	444,766	89,023	0·75
1950	462,014	161,705	1.30
1951	377,578	245,425	1.25
1952	466,892	163,323	1.25
1953	509,105	218,915	1.20
1954	720,944	295,587	1.15

The area is served with hydro-electric power. The original development was the Aberfeldie plant on the Bull River, now operated by the East Kootenay Power Co. Ltd., whose headquarters are at Fernie. Using 275 feet of water head, two generators produce 5,000 K.V.A. Owned by the same company, another plant is operated on the Elk River, near Elko. It uses 190 feet of water head to supply two generators which develop 12,000 K.V.A. A steam auxiliary station at Crowsnest Lake produces 10,000 K.V.A.

The transmission system connects the several generating stations with the entire Crowsnest Pass area, and with Cranbrook and Kimberley, and there is interconnection with the Calgary Power Co., Ltd. Additional power comes to Kimberley by way of a transmission line from hydro-electric plants operated by the Consolidated Mining and Smelting Co., Ltd. on the Kootenay River between Nelson and Castlegar.

Fernie is the largest center of population in the Elk River valley. Incorporated as a city in 1904, the population at one time was nearly 5,000, but the decline of the 1930's brought a reduction from which recovery is incomplete. The 1954 population of Fernie was little over 2,700.

Michel and Natal are two small towns adjoining one another about 22 miles northeast of Fernie on the main highway through the Crowsnest Pass. Settlement of Michel began in 1900, followed by development of Natal in 1908, the 1954 combined population being about 1,600. A new subdivision, Sparwood, located about two miles west of Natal, is intended for the establishment of new homes well away from the smoke and soot of the coke ovens.

The main industry around Fernie, Michel and Natal is coal mining and processing. Production amounts to from 1,100,000 to 1,300,000 tons annually of coal suitable for coking. Approximately 150,000 tons of coke are produced each year, and by-products are recovered. The estimated coal reserves in this area are from three to five billion tons.

Villages and post offices within the mapped area include Hosmer and Morrissey in the Elk River valley and Roosville, Flagstone (Grassmere), Newgate, Waldo, Baynes Lake, Elko, Galloway, Jaffray, Wardner, Bull River, Mayook, Rampart, Wycliffe, Marysville, Chapman Camp, Ta-Ta Creek, Wasa, Springbrook and Canal Flats in the Rocky Mountain Trench.

There are 18 elementary schools in the mapped area. These are located at Canal Flats, Sheep Creek, Wasa, Kimberley, Blarchmont, Chapman Camp,

* D. W. Munro, Assistant Forester, Forest Service, Nelson, British Columbia. Private communication.

Marysville, Cranbrook, Fort Steele, Mayook, Wardner, Jaffray, Grassmere, Waldo, Newgate, Elko, Fernie and Michel. There are high schools at Kimberley, Cranbrook, Waldo, Fernie and Michel. In 1954 the total school population amounted to 4,444.

The B.C. Telephone Co. maintains a line from Cranbrook to Canal Flats to the Crowsnest Pass, and to Roosville on the border of Montana. This line is connected with Alberta and Montana, and western points in British Columbia. The Canadian Pacific Railway Co. has a telegraph service along the railway lines. Telegrams are delivered to some of the rural points over the telephone system. The Canadian Broadcasting Corporation serves the mapped area from a booster station at Cranbrook. There are no communications in the 36 miles of valley along the Kootenay River upstream from Canal Flats.

Transportation

Most of the Wild Horse Creek gold found an outlet into the United States, thus promoting considerable trade by pack train. In the 1860's and 1870's goods were brought in from the south by pack train because no established trade routes existed from the west or east. Completion of the Great Northern Railway in 1883 and the C.P.R. main line in 1885 provided more convenient outlets to north and south. The railways were connected by steamboats on the upper Columbia and Kootenay rivers. The first steamboat on the Upper Columbia River, the Pert, carried passengers and freight to MacGillivray's Portage (Canal Flats). MacGillivray's Portage was connected by stage with Fort Steele, where the S.S. *North Star* served on the Kootenay River between Fort Steele and Jennings, Montana. In 1886 a canal was built at MacGillivray's Portage to turn part of the Kootenay River freshet into the Columbia. This was part of a scheme to reclaim a section of the Kootenay River flats in the vicinity of Creston. Fearing damage to the railway line around Golden, the C.P.R. objected to northward diversion of water and the objection was sustained. Thereafter an attempt was made to construct wooden locks and convert the canal for use by river boats. However, the canal proved to be inadequate and was used only three times by river steamers.

By 1895 the extent of the coal deposits in the Crowsnest Pass had been estimated, and the silver-lead ores of the Cranbrook locality looked important. Similar mining development was taking place in the West Kootenay district. These events required improvement of transportation and gave promise of profitable railway operation.

The Crowsnest Pass Railway, from Fort McLeod, Alta., to Kootenay Landing, started building in 1897 and was completed to Kootenay Landing in 1898. With Cranbrook the division point, a branch line was built to Kimberley in 1899. Connection was made at Yahk by the Spokane International Railway in 1907. The Kootenay Central Railway, connecting Golden with the Crowsnest Pass line near Wardner, was built in 1911-13. Completion of the Kootenay Central Railway ended the need of river transportation.

Between 1902 and 1908 the Great Northern and Crowsnest Southern Railways built a line connecting Rexford, Montana, with Michel. However, this railway did not prosper and the section between Michel and Elko was abandoned in 1926. The connection between Elko, Gateway and Rexford was maintained for another decade and abandoned in 1936.

As of 1954 the mapped area is served by a daily passenger train service between Vancouver and Fort McLeod, Alta. There is one train a week each way between Cranbrook and Golden. The heavy freight traffic moves coal, ore concentrate, coke, lumber and oil. Stockyard pens are available to ranchers at railway sidings.

Trucking routes pass east and through Cranbrook and the Crowsnest Pass. A second route goes north from Cranbrook to Golden. There is a daily refrigerator truck service. From Cranbrook the passenger bus lines run east through the Crowsnest Pass, and north to Golden, Radium, Banff and Jasper National Parks and to Calgary. Another bus line connects Cranbrook with Vancouver and the United States. Local stages connect Cranbrook with Kimberley and Fort Steele. The Canadian Pacific Airline through the district, established in 1947, uses the Cranbrook Municipal Airport as a stopping point east and west six days a week.

Arterial Highway 3-95 connects Cranbrook with Kingsgate at the border of Idaho, and the western part of the Province. Highway No. 95 connects Cranbrook with Golden and the Big Bend, and with roads from Golden and Radium through the National Parks. Southern Provincial Highway No. 3 connects Cranbrook with the Crowsnest Pass and Alberta. In the southern section there is access to Montana by road 93 between Elko and Roosville, by way of Baynes Lake and Waldo.

The Kootenay River valley upstream from Canal Flats is accessible by road to the Palliser River in dry weather. There is also a dirt road in the Elk River valley, extending north from Natal. This road is gravelled for a few miles and may be used for 40 miles or more northward in dry weather. In addition to public roads there is an extensive network of logging roads, old and new, that can be used safely during the dry summer season.

Agriculture

An agriculture based on grazing has continued since the days when the Kootenay Indians fed their horses on the natural grasslands. However, the highly calcareous soils appear to intensify the effect of drought, hence the carrying capacity of the range is low. As the livestock population grew the range became overgrazed, particularly in areas near water. The original grasses have more or less disappeared, their place being taken by a scanty growth of secondary grasses and weeds of lower feeding value. The present condition of the range is such that there is great need for better management.

As the grass thinned out, the wild horses were hunted and destroyed, and present competition for grass is with game, which is fairly plentiful. The existing cattle population is about as large as the range will support, with the possible exception of a few localities with no easily available water supply.

The numbers of cattle shipped and consumed locally indicate the amount of beef the mapped area can yield under the present conditions. This is given for several years as follows: *

Year	Cattle shipped	Hides	Total
1945	2,285	1,363	3,650
1946	1,887	1,775	3,662
1947	1,834	1,730	3,564
1948	2,704	1,487	4,191
1949	2,002	1,756	3,758
1950	3,008	784	3,792
1951	2,290	497	2,787
1952	1,722	476	2,198
1953	2,609	1,028	3,637
1954	2,652	443	3,095

The beef cattle off the range are sold chiefly in Alberta markets as feeders. Those with enough finish go directly to the packers. The numbers of head consumed locally are shown as hides in the above table, and these are mostly calves and yearlings.

* J. W. Awmack, District Agriculturist, Cranbrook, B.C., private communication.

The total population of beef cattle in the mapped area amounts to about 9,000, dairy cattle 1,200, sheep 250, hogs 350 and poultry 27,000. During the second world war there was a trend from dairy to beef production, largely due to labor shortage, and this trend continues. Sheep ranching is limited by predatory animals, mainly coyotes, which are difficult to control in mountainous country. The number of hogs is kept down by low production of suitable feeds.

Between Canal Flats and Montana the present agricultural development is based on the number of choice locations adjacent to range. These consist of the higher bottoms on the Kootenay River and easily irrigated fans and outwash of tributary streams. Such areas are limited by size and water supply, and their number is small in comparison with the size of the district. An exception is St. Mary's Prairie, where dry farming is practised. While in the best years yields of 40 bushels of wheat per acre have been reported, the average yield is less than 15 bushels per acre.

Since the Kootenay River flats are subject to flood and the locations with easily available irrigation water are limited, agricultural development has been stalled since the pioneer days. In the area between Canal Flats and Montana, the agriculture will remain passive until a fundamental change of economic conditions warrants irrigation on a project scale.

An early attempt to break away from the pioneer agricultural regime in the Rocky Mountain Trench was made during a period of speculation before the first world war. Since the colonization was chiefly English, the war brought quick collapse and abandonment of a venture that would otherwise have died slowly. Acreage was sold around Cranbrook and Baynes Lake in small holdings for production of tree fruits. The advertising of 1905 to 1909 called Cranbrook the "Land of the Big Red Apple". Five to 20 acre cleared lots were sold for from $75.00 to $100.00 per acre. It took until 1915 to prove to some settlers that Cranbrook is not a tree fruits area.

The Great Northern Railway between Newgate and Morrissey was built in 1902, and Baynes Lake became a division point. The area was logged and by 1910 there was a population of about 1,500 between Baynes Lake and Newgate. Around 1910 a land company got a water right on Rock Creek, and by 1912 some 357 acres were under irrigation. The land company installed the works and sold most of the acreage in England as tree fruit land. The system gradually deteriorated and by 1924 only 41 acres were irrigated. The Great Northern Railway abandoned Baynes Lake in 1936, leaving what amounts to a ghost town. Today the irrigation system is no longer operating and little evidence of an active community remains.

In 1954 there were about 300 farms in the area between Canal Flats and Montana, with about 19,000 acres under some form of farm management. Included in this amount are 38 farms on the Kootenay River second-bottoms, which have approximately 2,800 acres cleared and used for hay, pasture and other crops. Above the Kootenay River trench the balance of 16,200 acres consists of cleared farm land and pasture, about 3,850 acres being under some form of irrigation.

Farm development in the Elk River valley amounts to 117 farms with a total of 2,750 acres under cultivation and pasture. This area supports 1,000 beef cattle and 500 dairy cattle, the beef cattle being pastured at high elevations in summer. The farms vary in size, averaging about 40 acres of crop and pasture land. The chief crops are hay, alfalfa, oats, wheat, barley, rye, potatoes and vegetables. Acreages of field crops in 1951 amounted to 1,730 acres of hay, 600 acres of alfalfa, 200 acres of oats, 98 acres pasture, 50 acres of wheat, 40 acres barley, and 33 acres of rye.

In parts of the mapped area the production of seed potatoes is a cash crop combined with ranching. The advantages of producing seed potatoes consist of availability of new land, isolation of farms from one another, and freedom from disease and insect pests. Local potato yields average about 12 to 14 tons per acre.

Small acreages devoted to market gardens are located near Fernie, Cranbrook and Kimberley. Such gardens produce vegetables that do well under cool climatic conditions. The very hardy vegetables include cabbage, turnips, rutabagas, kohlrabi, horseradish, spinach, beets, parsnips, rhubarb, kale, Swiss chard, radish and parsley. Crops that grow well and survive varying degrees of frost damage include potatoes, cauliflower, lettuce, carrots, celery, onions and peas. Crops with still less frost tolerance are grown in farm gardens and in favored locations. These include squash, beans, vegetable marrow, tomatoes, cucumbers, pumpkin, citron and sweet corn.

At the lower elevations the production of tree fruits for home use can be undertaken if a favorable location is available and hardy varieties are selected. The East Kootenay region is not suitable for commercial tree fruit growing, although there is one commercial orchard in a special location in the vicinity of Roosville. While raspberries and certain other small fruits are subject to lime-induced chlorosis, they may be grown on well-drained slopes.

Farm organizations include the Cranbrook Farmers' Co-op, which does business in feeds, fertilizers and farm machinery. There are farmers' institutes at Ta-Ta Creek, Cranbrook, Wardner, Jaffray, Baynes Lake, Newgate, Grassmere and Fernie. The ranchers maintain the Waldo Stock Breeders' Association and the East Kootenay Beef Growers' Association. Other organizations consist of the East Kootenay Seed Growers' Association, Women's Institutes at Flagstone and Jaffray, and a Junior Club at Newgate.

Government services benefiting agriculture consist of the Department of Agriculture district office at Cranbrook and the East Kootenay Public Health and Social Welfare Offices at Cranbrook and Fernie.

Owing to the summer-dry climate, which to a greater or lesser degree applies to the whole map area, the development of agriculture beyond the present pioneer stage is dependent upon the extensive use of irrigation.

Climate

Moisture laden air from the Pacific dominates the weather of British Columbia at all seasons. Heavy rains and snowfalls result from the ascent of moist Pacific air on the western slopes of the mountain ranges. Precipitation is light on the eastern slopes of the mountains, and semi-desert conditions prevail at the lowest elevations in parts of the interior valleys.

The Kootenay River valley, in the southern part of the Rocky Mountain Trench, is higher than the dry valleys to the west, and therefore not so warm and dry as the most arid climate in the Province. However, it is semi-arid, with an annual precipitation of about 14 inches.

Most of the main interior valleys in the southern part of the Province have a more or less north-south direction. They provide a path for masses of cold continental air from the north, particularly in winter, and for heated air from the southern plateaux of the United States in summer. There is a wide annual temperature range and the Kootenay River valley conforms to the general pattern.

Cold air from the north in late spring, summer and early fall may cause frosts because humidity is low and night radiation is rapid. Frosts have been reported at Cranbrook in all months of the year. However, if the local warm air contains a good store of water vapor, the invading cold air may bring rain to the valley and snow to the high mountains, or a succession of thunder storms. In winter the southward movement of cold air may bring low temperatures, an extreme of —42°F. being on record. Warm air currents from the south in summer sometimes give temperatures in excess of 100°F.

Temperature

The temperature information is confined chiefly to 5 stations between Newgate, including Fernie, and the Kimberley Airport, near Wasa. There is no information for the area between Wasa and Canal Flats. Taking the difference of elevation into account, the annual means are closely related. Newgate, at 2,800 feet elevation, has a mean annual temperature of 43°F., while Fernie at 3,300 feet has a mean of 40°. Cranbrook, Kimberley Concentrator and Kimberley Airport, at elevations between 3,000 and 3,500 feet, have an annual mean temperature of from 40 to 41°F.

Average winter temperature for December, January and February, are 22° at Newgate, 19° at Fernie and 20° at Cranbrook. The annual records of the other two stations are too few for reliable averages. Fernie has the lower temperature, owing to its higher elevation. Spring temperatures are the average of monthly means for March, April and May, and are useful to show comparative earliness of the season. These are 44° at Newgate, 40° at Fernie and 42° at Cranbrook.

The summer temperature consists of the average monthly means for June, July and August. These are 63° at Newgate, 59° at Fernie and 61° at Cranbrook, with differences based on elevation. Autumn temperatures for September, October and November are 43° at Newgate, 41° at Fernie and 41° at Cranbrook.

In an undeveloped area these figures have little significance without comparison. When compared with the same data for the Creston and Okanagan tree fruits localities, shown in Table 1, it may be seen that the seasonal temperatures in the mapped area are too low to support a tree fruits agriculture, or an agriculture that requires the same amount of seasonal heat. For some purposes it is desirable to supplement the seasonal temperature with monthly means. The monthly means for the 5 temperature stations in the map-area are given in Table 1, in the appendix.

Table 1. Average Seasonal Temperatures of Some East Kootenay Stations Compared with Creston and Okanagan Stations. (Deg. F.)

Station	Elevation	Winter	Spring	Summer	Autumn	Year
	Feet					
Newgate	2,800	22	44	63	43	43
Fernie	3,300	19	40	59	41	40
Cranbrook	3,013	20	42	61	41	41
Kimberley Concentrator	3,500	21	40	62	42	41
Kimberley Airport	3,016	18	41	62	42	40
Creston	2,000	25	45	63	44	44
Vernon	1,383	26	48	66	46	47
Kelowna	1,200	28	47	65	47	47
Penticton	1,121	30	48	66	48	48

The data for temperature extremes and snowfall are scanty, as shown in Table 2. A high of 103°F. was recorded at Newgate in 1924 and 108°F. is on record at Kimberley Airport. A low of —42° occurred at Cranbrook in 1950. These extremes indicate the range of temperature in the mapped area.

Table 2. Extreme Temperatures and Average Snowfall of Some East Kootenay Stations

Station	Years of record	Temperature (°F)		Snowfall (Inches)
		High	Low	
Newgate	1918—53	103	−40	41·2
Elko	....	....	....	49·9
Fernie	1916—53	97	−40	131·3
Cranbrook	1916—53	102	−42	56·7
Kimberley Concentrator	1934—48	100	−30	110·0
Kimberley Airport	1943—53	108	−40	60·4
Wasa	1922—50	....	....	50·4
Canal Flats	1918—50	....	....	44·5

No climatic data are available for the upstream area on the Kootenay River between Canal Flats and the National Park boundary. Observations in this area indicate cooler and more humid climatic conditions than those at Canal Flats.

In the Elk River valley there is temperature information from a station at Michel, elevation 3,800 feet, for the years 1918 to 1920, and for 1951 at Natal at about the same elevation. In these four years the annual mean varies from 34° to 41°F., the average being 38·25°F.

The Growing Season

The growing season varies with plant species, according to their ability to resist low temperatures. For the most hardy plants the growing season begins at approximately 43°F. mean temperature in spring and stops when the same temperature is approached in the fall. On this basis the growing season at Cranbrook begins on April 15, and stops 180 days later on October 12. In higher parts of the map-area the growing season is shortened by from 10 to 20 days. This compares with growing seasons of 193 days at Creston, 200 days at Vernon and 217 days at Penticton.

Frost records for each locality over a period of years furnish an estimate of the safe dates to plant and harvest frost-tender crops and, for this purpose, are of great value to the farmer. The available frost data for stations in the mapped area are shown in appended Table 2.

The amount of heat in the growing season varies with the elevation, and provides an additional means of expressing climatic conditions. Summer heat is an important limiting factor in Canada, so the agriculture of each locality is gradually adjusted by local experience to take advantage of the average heat content of the local climate. Using the base of 43°F. the total heat units in the growing season at Cranbrook amount to 9,937, compared with 10,565 units at Creston, 11,444 at Vernon and 12,454 at Penticton. While heat in the growing season is less than in the tree fruits localities, it is greater than that of the mixed-farming Prince George district, the total heat units at Prince George being 9,502.

Precipitation

Summer rain is chiefly in the form of thunder storms which follow more or less definite storm tracks. They enter the Rocky Mountain Trench through wind-gaps in the Purcell Mountains, and angle across to the nearest gaps in the Rockies. These tracks can be followed by the more abundant vegetation, some different plant species, and in the amount of leaching that has taken place in the soils.

In summer, thunderheads commonly appear over the Purcells to the north and south of Waldo and cross the Trench. Most of these storms enter the Rockies at Elko, and follow the Elk River valley. Storms from the southwest that miss the Elko gateway follow the Rockies northward and enter by way of the Bull River valley.

At Elko, where the Elk River enters the Rocky Mountain Trench, the annual precipitation is 20·10 inches at 3,100 feet elevation. The dry area extends about 8 miles eastward to a point where the valley widens near Morrissey, and a remarkably humid pocket is entered which extends for a few miles northeast of Fernie. In the humid area the annual precipitation amounts to 40 inches or more, the total for Fernie being 39·60 inches.

Between Fernie and Natal, and to the north of Natal, the volume of native vegetation could be supported by from 20 to 25 inches of annual precipitation. Information on precipitation is available from Michel, 3,800 feet elevation, for the years 1918 to 1920. The annual precipitation varied from 27·8 inches in 1918 to 15·4 inches in 1920, the average being 22·5 inches. The snowfall varied from 90·55 inches in 1918 to 15·3 inches in 1920, which was a very dry year. In 1951 the snowfall at Natal amounted to 152·5 inches, the same year having a record fall of snow at Fernie.

Farther north in the Rocky Mountain Trench, thunderheads have their origin in the St. Mary River wind-gap in the Purcell Mountains. After entering the Trench at Marysville they may go north or south. The storms going south enter the Rockies at Bull River, while those travelling north follow the Kootenay River above Canal Flats. Since the meteorological stations at Elko and Canal Flats are situated where storms enter the Rockies, they show higher precipitation than the stations located elsewhere. Annual precipitation at Canal Flats amounts to 16·31 inches at 2,680 feet elevation. No meteorological information is available for the upstream area, but there is an increase in the volume of vegetation and in the leaching of soils, the more humid areas having spotty distribution. Similar densities of vegetation under comparable conditions suggest that precipitation in the vicinity of Gibraltar Rock is about 18 inches annually.

To some extent the snowfall is related to elevation, the average for Newgate being 41·2 inches at 2,800 feet, whereas the Kimberley Concentrator at 3,500 feet elevation has an average snowfall of 110 inches. The average snowfall for these and other stations is shown in Table 2. In the Rocky Mountain Trench the amount of snow varies from year to year. The high and low at Newgate amounts to 86 and 21 inches, at Cranbrook 103 and 6 inches, and at Wasa 100 and 26 inches. At Fernie the snowfall extremes are greater than in the Trench. From 1916 to 1951, the lowest snowfall at Fernie was 57·1 inches in 1930, and the high was 229·9 inches in 1951.

The general pattern of the Pacific inshore climate is featured by high winter precipitation and summer dryness. This pattern is typical of the climate of the Lower Fraser valley. Vernon, in the Okanagan valley, has a lower total and less winter precipitation. However, there is greater precipitation in December and January than in other months, excepting June, which provides the chief departure from the Fraser valley climate. Farther east at Cranbrook the curve has more modification. While December and January precipitation continue to give the curve its characteristic U-shape, the May and June rainfall is more strongly emphasized than at Vernon. At Fernie, where the volume of precipitation is high, the curve would be accepted as from a station in the Lower Fraser valley, except for the more pronounced June rainfall. These features are illustrated in Figure 1. The precipitation pattern comparing stations in the map-area is shown in Figure 2.

Appended Table 4 gives average monthly and annual precipitation for the several meteorological stations. The average annual precipitation in the summer-dry Rocky Mountain Trench is about 14 inches, but the averaged years show wide fluctuation. At Newgate the annual high is 20·30 and the low 8·73 inches. At Cranbrook the high is 22·73 inches and the low 3·07 inches. At Wasa the annual variation is between 25·29 and 8·73 inches. Fernie should be regarded separately, owing to the greater precipitation in that locality. At Fernie the annual precipitation high is 58·53 and the low 26·96 inches in the years between 1916 and 1953.

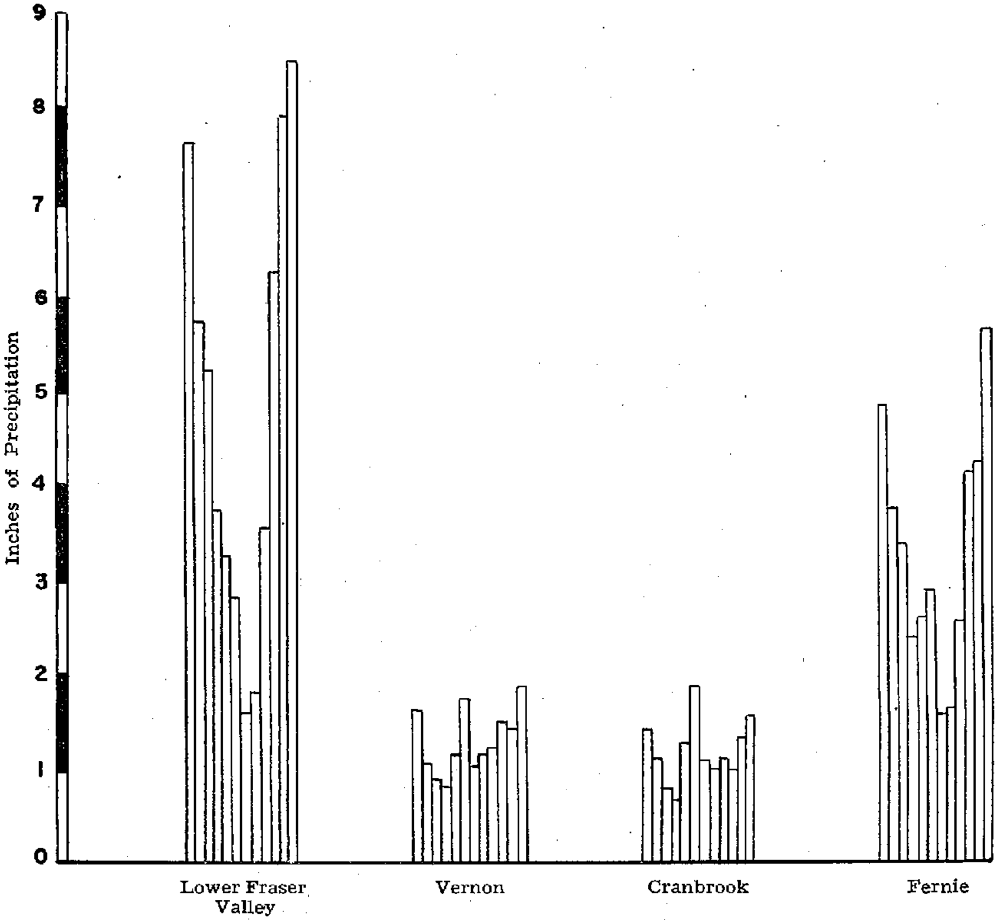

FIGURE 1. Precipitation pattern, January to December, comparing the Coast with the Southern Interior. The inshore climate is characterized by high winter precipitation and summer dryness, the bulk of the moisture being dropped on the western slopes of the mountain ranges. In the Interior there is winter accumulation of snow and a substantial spring freshet. The summer is dry except for June rains.

Using the average figures, the rainfall in an irrigation season from May to September inclusive, is 5·55 inches at Newgate, 8·72 inches at Elko, 11·22 inches at Fernie, 6·29 inches at Cranbrook, 6·36 inches at Kimberley Airport, 6·31 inches at Wasa, and 7·44 inches at Canal Flats. These figures show the comparative moisture deficiency of soils that require from 12 to 48 acre inches annually for irrigated agriculture.

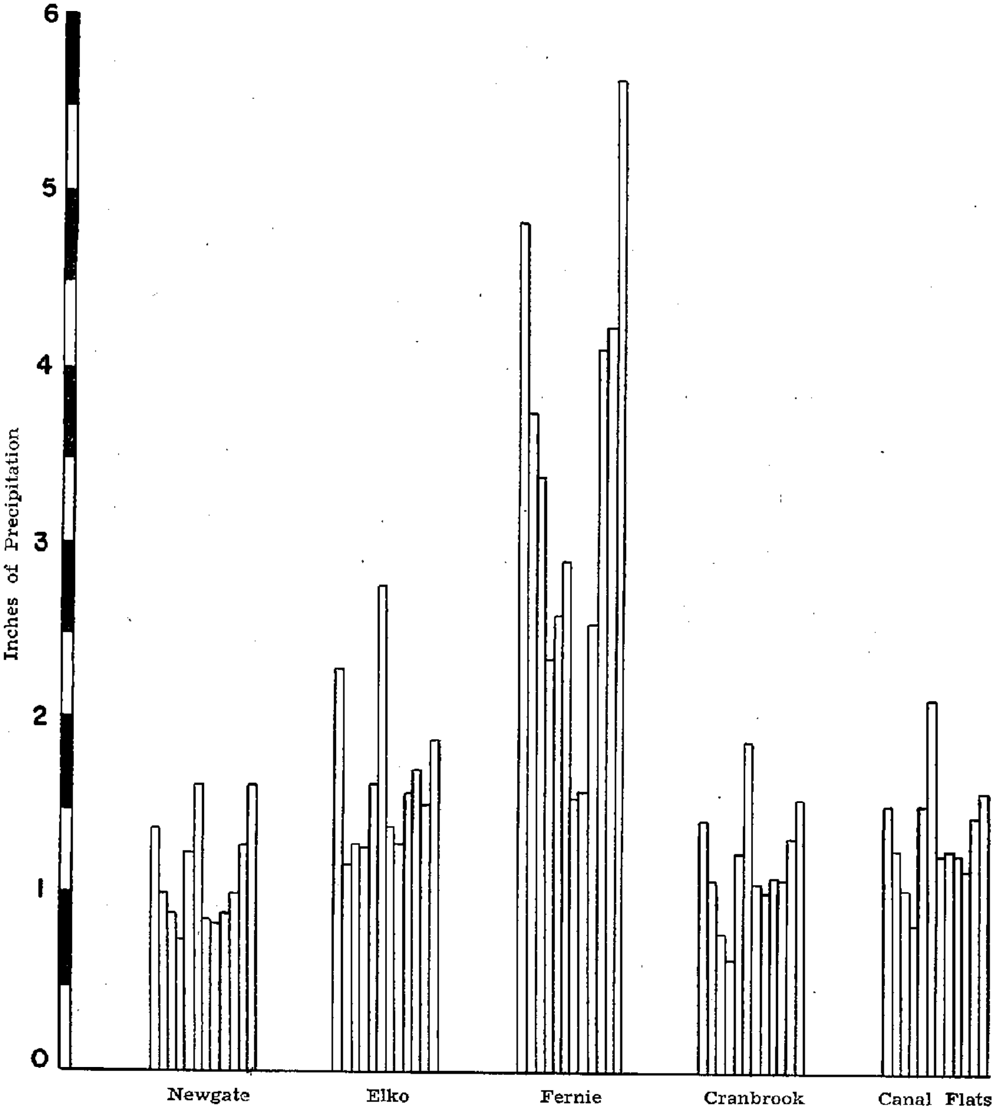

FIGURE 2. Precipitation pattern, January to December, for the upper Kootenay and Elk River valleys. The humid climate around Fernie is emphasized. The highest volume of precipitation in the mapped section of the Rocky Mountain Trench is at Elko and Canal Flats, where storms enter the Rocky Mountains. Note that the rainfall peak is in June, except at Fernie.

Sunshine, Cloudiness and Wind

The only sunshine station was at Windermere, about 20 miles north of the map-area. This station operated from 1914 to 1939, and the climatic conditions are similar to those farther south. The average shows general cloudiness in November, December and January, with 62, 48, and 62 hours of sunshine. In the balance of the year there is much broken cloud and clear weather, hours of sunshine rising from 103 in February to 300 in July. The annual average for 26 years is 1,980 hours, the high being 2,185 and the low 1,747 hours. Thirteen of the 26 years had more than 2,000 hours of sunshine. The annual hours of sunshine compare with Kamloops and Summerland.

An anemometer at the Cranbrook Airport, for the years 1938 to 1945, gives wind directions as follows: South, southeast and southwest 63 per cent; north, northeast and northwest 29 per cent; east 3 per cent; west 3 per cent and calm 2 per cent. Average wind speed per annum is about 6 miles per hour, the north winds being 4·5 m.p.h. and the south winds 7·1 m.p.h. Maximum hourly wind velocities range from 17 to 20 m.p.h. These are southerly winds; no northerly winds achieve these velocities.

From 1938 to 1948 the maximum wind mileage for any month was in February, 1944, with 7,072 miles, the minimum month being November, 1947, with 2,193 miles. April has the highest average of any month with 5,308 miles. The average annual mileage of wind at Cranbrook for 10 years is 53,277 miles. This compares with a yearly total of about 38,000 miles at Prince George and 54,000 miles at Summerland in the Okanagan Valley.

Native Vegetation

In the Kootenay River valley, from Canal Flats to the National Park boundary, the climate gradually becomes more humid and cooler as elevation is increased. Upstream from Canal Flats the vegetation gradually becomes more dense and the tree species change their order of importance. The change is from a mixed forest of fir and larch with spruce at higher elevations to invasion of the valley bottom by spruce in the northern part, and partial elimination of fir and larch. Where the original growth has been destroyed the most common secondary tree is lodgepole pine, with aspen and willow inclusion on the finer textured soils.

The Elk River valley climate is humid around Fernie, yielding coastal type vegetation including cedar in the valley bottom. Northeastward the climate dries off but elevation is higher and rainfall greater than the Upper Kootenay River valley area described above. Upstream from Fernie the spruce is climax, but most of the valley bottom has been burned over and little of the original timber remains. Aspen is abundant on the heavy soils, and lodgepole pine is common on the sandy and gravelly areas.

The Rocky Mountain Trench, in the area between Montana and Canal Flats, forms a fairly definite vegetation zone, the elevation being from 2,310 feet at river level on the 49th parallel to 3,500 feet at the toe of some of the mountain slopes. The surface of the Trench is broken by knolls and ridges, river and stream valleys and deep canyons, giving a variety of drainage and exposure and changes in the composition of vegetation.

The two general types of vegetation are forest and natural grassland. At one time forest covered most of the area, but this has been logged and most of the mills have closed down. The reduction of the logging industry is due to removal of the original stand of trees, which were sparse, and the slow rate of regeneration.

The most characteristic tree of the area is the yellow or bull pine (*Pinus ponderosa*), which is abundant to Canal Flats, north of which it becomes scarce. The ponderosa pine occupies the hot, dry areas where it may form almost pure stands, as at Rampart, Waldo and parts of Tobacco Plains. More usually it is mixed with Douglas fir (*Pseudotsuga taxifolia*) in varying degrees, which may also form almost pure stands. Owing to the scattered nature of the growth, the young firs in this area are well shaped and to a large extent they are harvested for the Christmas tree market.

Western Larch (*Larix occidentalis*) occurs typically in somewhat moister conditions, but between Cranbrook and Kimberley and elsewhere, the pine, fir and larch may be seen growing in the same clump. Both white and Engelmann's spruce occur chiefly along creeks and river flats, where there is abundance of moisture, but at St. Eugene Mission the ponderosa pine and spruce may be seen growing side by side. Rocky Mountain juniper *(J. scopulorum)* occurs occasionally throughout the district.

The forest type produced by these trees is mostly open with a thin ground cover of grass mixed with forbs and dwarf shrubs. In logged and burned areas visited by summer storms there is a little more moisture and typical dense stands of lodgepole pine (*Pinus contorta*) may occur, as in the Jaffray locality. In the creek bottoms there is a dense stand of moisture-loving trees and shrubs including cottonwood, aspen, willows, alder *(Alnus tenuifolia)* and Mountain maple *(Acer glabrum)*. Aspen *(Populus tremuloides)* is found throughout the district in moist hollows among the conifers.

The most common shrub is the antelope bush *(Purshia tridentata)* which occurs throughout the area, except in the moist belt at the foot of the mountains. It reaches maximum development as to numbers and size on logged-off land southwest of Elko. In the Rocky Mountain Trench the existence of this plant between Montana and Canal Flats probably depends on the dry soil conditions in summer. Other common shrubs are wild rose, choke cherry *(Prunus demissa)*, mock-orange *(Philadelphus Lewisii)*, bearberry *(Arctostaphyos uva-ursi)* and snowberry or waxberry (*Symphoricarpos* (chiefly) *occidentalis*).

Areas of natural grassland are small, the two most important being St. Mary's Prairie, between Cranbrook and Marysville, and Tobacco Plains near the Montana border. These and most other areas have been overgrazed, and it is not easy to determine the nature of the original vegetation. Relatively undisturbed patches are small and not typical in situation. However, in such places blue bunch grass (*Agropyron spicatum* var. *inerme*) is usually dominant, and as this is one of the best forage grasses it seems probable that it originally occurred over the whole area. Rough fescue *(Festuca scabrella)* is also frequent along with Idaho fescue *(F. idahoensis)*, which seems to stand overgrazing better and is often dominant on St. Mary's Prairie. All these are important forage grasses. Some local agriculturists consider rough fescue a poor grass, avoided by stock, but its abundance in protected areas, such as the railway right-of-way in comparison with open range, indicates that it has been eaten out on the latter.

Other abundant grasses are *Koeleria cristata, Poa secunda*, and *Stipa columbiana*. Associated plants are dwarf *Erigerons*, silky lupin *(Lupinus sericeus)*, poison milk-vetch *(Astragalus serotinus)*, *Antennaria parvifolia*, alum-root *(Heuchera glabella)*, poison camas *(Zigadenus venenosus)*, and many others, some of which are peculiar to the Rocky Mountain region. It seems, therefore, that the original vegetation was the Agropyron-Festuca association or Upper Grassland Zone as described by Tisdale* and Spilsbury and Tisdale.† This vegetation differs from the western dry belt of British Columbia in the much greater abundance of Idaho fescue.

While the above applies to most of the area, there are "islands" of considerable size, especially on Tobacco Plains, which are almost pure stands of needle grass *(Stipa comata)* or downy brome *(Bromus tectorum)*, or mixed

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* Tisdale, E. W.—The grassland of the southern interior of British Columbia, Ecology 28:346-382, 1947.

† Spilsbury, R. H., and Tisdale, E. W.—Soil-plant relationships and vertical zonation in the southern interior of British Columbia. Scientific Agriculture 24:395-436, 1944.

with *Poa secunda.* Tisdale considers such associations as derived by overgrazing from what was originally Middle Grassland Zone, so this zone may have been represented on hot, dry, gravelly soils of the Trench bottom.

Where overgrazing is extreme, the grass may have almost disappeared, with other vegetation in its place. In some cases patches of many square yards are occupied by false dandelion *(Agroseris glauca)*, a taprooted perennial. An annual woolly composite *(Filago arvensis)*, introduced from Europe and not known to occur elsewhere in North America, has almost taken possession of the overgrazed range at Dorr, and is abundant on much of the range south of Elko. It appears to be avoided by stock.

Skookumchuck Prairie is an area of gravelly terraces, classed with the Elko-Saha soils. The grass cover is almost pure *Stipa comata* with some *Bromus tectorum* and *Koeleria* in places. Forbs are abundant; *Erigerons*, pasture wormwood *(Artemisia frigida)*, *Antennaria parvifolia*, bitter-root (*Lewisia rediviva*), *Phlox rigida*, *Eriogonum flavum*, woolly plantain *(Plantago Purshii)* and others, are present. A prairie near Wasa is of the same character, both being derived from the Middle Grassland Zone by overgrazing.

In addition to the grasses previously mentioned, certain plants favor the most excessively dry positions. *Eriogonum flavum*, a perennial, restricted in British Columbia to this section, is one of them. The less common *Penstemon eriantherus* likes a dry habitat, and the lesser paintbrush *(Orthocarpus tenuifolius)* is a common annual in such places.

Sage brush *(Artemisia tridentata)* and cactus *(Opuntis sp.)*, conspicuous plants of the western dry belt, do not occur. Rabbit bush *(Chrysothamnus nauseosus)* and balsamroot *(Balsamorhiza sagittata)* are found only here and there on hot, dry and usually southern exposures.

Although local variations in the character of the vegetation occur, there is little evidence of zonation, except that the vegetation becomes mesic in areas avoided by summer storms, particularly on south exposures and where soils are shallow and gravelly.

There is a slight general change in the vegetation from south to north, due to the varying degree to which certain plants of southern origin have been able to extend themselves northward. Thus the reed grass *(Calamovilfa longifolia)* only occurs for a few miles north of the Montana boundary; *Eriogonum flavum*, *Orthocarpus tenuifolius*, and *Phlox rigida* extend as far as Skookumchuck and Wasa, while the antelope bush (*Purshia*) stops about 10 miles south of the Kootenay River crossing at Canal Flats.

On the Kootenay River floodplains, which are very limey, alkali grass *(Distichlis stricta)* and rush-leaved meadow grass *(Poa juncifolia)* were found in comparatively dry areas, and poisonous arrowgrass *(Triglochin maritima)* was seen around the ponds.

Physiography

From the National Park boundary near the mouth of Cross River, the Kootenay flows southward in a valley from two to three miles wide for a distance of 22 miles to Gibraltar Rock. At the Park boundary the river elevation is about 3,500 feet, and at Gibraltar Rock at water level the elevation is about 2,900 feet. In this area the post-glacial troughs of the Kootenay and its tributaries, the Cross, Palliser and White rivers, are cut 150 feet or more into the valley bottom, and in places on the Kootenay there are a series of terraces. The high part of the glaciated valley bottom is covered by moraines and glacial outwash, the range of elevation being from 3,000 to 3,800 feet above sea level. On each side the Stanford and Mitchell ranges of the Rocky Mountains rise to alpine ridges and summits relatively free of snow in summer.

Just below the mouth of the White River the valley narrows abruptly at Gibraltar Rock, which was recently investigated as a dam site. Downstream from Gibraltar Rock the deeply cut valley, now only one half mile from wall to wall, swings southwest around the south end of the Stanford Range for a distance of 14 miles to Canal Flats, where the Kootenay River enters the Rocky Mountain Trench.

The Rocky Mountain Trench is a great longitudinal depression extending from Montana to the Yukon. In the mapped area the Trench consists of a glaciated valley from 3 to 17 miles wide, with the Rocky Mountains rising abruptly from the valley floor on the east. On the west the Purcell Mountains begin as rounded and wooded foothills, which give way to rugged mountains. Aside from the fringing mountain systems the most striking topographic feature is the broad, gently sloping channel of the Kootenay River, which follows a slightly meandering course in the Trench bottom. From north to south the river channel is from one half to two miles wide, with banks up to 100 feet or more in height. The river swings from the west side to the center of the Trench and back towards the west in the southern part.

The river channel is filled with tree-covered second bottoms, treed levees, and grassy and swampy floodplains. River elevation at Canal Flats is 2,680 feet, and at Newgate on the border of Montana, the water level is 2,310 feet above the sea. The 370 foot descent in 83 miles is fairly fast at both ends, and slow in the middle of the mapped area. On each side of the channel the topography consists of a rolling till-plain, eroded by shallow, flat bottomed glacial river channels and scarred by the more deeply cut courses of tributary streams. The till-plain is marked, here and there, by hills and ridges of exposed bedrock. The average till-plain elevation is about 2,800 feet, and the range of elevation is from 2,600 feet to 3,700 feet above sea level.

The Elk, a glaciated river valley, runs north from Natal between two mountain ranges. From Natal it angles southwestward, cutting across several mountain ranges, and enters the Rocky Mountain Trench at Elko. The valley was surveyed about 30 miles north from Natal and 41 miles southwest from Natal to Elko. At the north end of the map-area the river elevation is about 4,300 feet and the valley bottom is about one half mile wide. On each side the mountains rise to high ridges and to summits in excess of 9,000 feet elevation. The greatest valley width is 4 miles, the widest place being a few miles north of Natal. At this point the valley fill of glacial origin rises to about 4,200 feet elevation. Near Natal the river runs southwest at about 3,700 feet elevation. This part of the Elk River valley is approximately a mile wide and elevations above river level range up to 3,800 feet around Natal, 3,300 feet at Fernie and 3,100 feet at Elko. The river elevation at Elko is about 3,000 feet above sea level. The channel of the Elk River is lined with a series of terraces, above which alluvial fans are common along the toe of the mountain slopes. At the mouths of side valleys there are masses of rolling moraines, originally deposited in the main valley by tributary glaciers. The river meanders from side to side of the main valley around these morainal deposits. On entering the Rocky Mountain Trench the Elk River flows southward a short distance in a deep, post-glacial canyon to join the Wigwam, and then flows southwest to the Kootenay River.

Drainage

The main drainage outlet is the Kootenay River, which is abundantly supplied with fast-flowing tributaries. Above Canal Flats, in the northern part of the area, the Cross, Palliser and White rivers, and Pedley, Fenwick and Cedrus creeks are important as contributors to the Kootenay and as potential suppliers of irrigation water. Below Canal Flats, Findlay, Skookumchuck and Sheep creeks are small tributary rivers. To the south of Skookumchuck, Wolf, Ta-Ta, Lewis, Cherry and Saugum creeks contribute small quantities of water. In the vicinity of Fort Steele, Wild Horse Creek and the St. Mary River enter the Kootenay from the east and west, and the Little Bull and Bull rivers come from the east just above Wardner. To the south of Wardner much water is contributed to the Kootenay by several important streams. These are Plumbob, Sand and Rock creeks. In the southern part of the area, Linklater and Gold creeks enter from the west, and the Elk River, which has many tributaries, increases the Kootenay River flow from the east.

The area is remarkable for the comparative scarcity of lakes and ponds. The few that occur are widely scattered. Most of these are in the Rocky Mountain Trench, in depressions caused by the melting of buried ice. Some of the smaller and shallower kettles formerly contained ponds, but these became sedge swamps, which matured as peat bogs. The only lakes worthy of the name are St. Mary Lake on the St. Mary River, in the Purcell Mountains about 10 miles west of Marysville, and Premier Lake which lies at the foot of the Rockies to the east of Springbrook. Small lakes used for recreation but of little value for fishing, include the Northrop Lakes near Bull River, and Emerald Lake to the northeast of Natal.

Above the Kootenay River channel in the Rocky Mountain Trench the soil drainage conditions are unusual. Saturation of the surface soil occurs to shallow depths once or twice a year. In the most humid season the amount of moisture in the lower part of the B horizon is moderate and the parent material of the soil is usually dry.

It would appear that the water from melting snow drains over frozen ground in the spring, with little or no penetration. The greatest depth of moisture occurs during the June rains. These are delivered chiefly by thunder showers of varying intensity and uneven distribution. There is no downslope seepage over impervious substrata, and no marl accumulation in the hollows. However, in the Kootenay River valley above Gibraltar Rock and in the Elk River valley, the climate is more humid and moisture penetration goes to greater depths.

Geology of Soil Parent Materials

The classification of soil parent materials is arranged in what is believed to be the order of deposition by ice and water. The following description applies to three sections of the mapped area, the Kootenay River valley upstream from Canal Flats, the Elk River valley and the Rocky Mountain Trench, Canal Flats to Montana. Since the two side valleys are tributary to the Rocky Mountain Trench, their groups of soil-forming materials will receive first consideration.

Upper Kootenay River Valley

This valley, south from the Kootenay National Park boundary to Gibraltar Rock, is from 2 to 3 miles wide. From Gibraltar Rock to Canal Flats the valley is deeply cut and about half a mile wide. The greater valley width above Gibraltar Rock is due partly to the soft bedrock and partly to a river course that follows a major fault zone. Downstream from Gibraltar Rock the river flows across the structural trend of the beds.

The soft bedrock in the northern part consists of an early Paleozoic group of rocks mapped by the Provincial Department of Mines as McKay Group Undifferentiated and Metamorphosed McKay Group.* The former contains limestone, limestone conglomerate and shale, and in addition to these constituents the latter contains beds of phyllite, a soft clayey product of intense shearing. The phyllite, exposed along the Kootenay and White rivers, is confined to a section about a mile wide in the valley bottom.

The McKay Groups were excavated extensively by glaciation and subsequent erosion. In this area they provide the unusual feature of a local bedrock to soil relationship, the first of its kind soil mapped in British Columbia. Several of the local soil types are directly related to this formation.

The first derivative is a clay-till, which lines parts of the valley bottom above the post-glacial channels of the Kootenay River and its tributaries. This is a comparatively stone-free till and the soil type derived from it was named Cedrus Clay.

During the decline of glaciation the tributary streams eroded both the soft McKay bedrock and the clay till and carried away the fine-textured material. Clay and silt were mixed with stones brought down at the same time to produce fans of this material, through which the streams cut subsequent canyons. These stony fans, now well above the level of present runoff, were differentiated as Nestor Silt Loam.

The early freshets of temporary streams eroded the clay till in places to form gently sloping fans of considerable size. These fans are composed of comparatively stonefree silt and clay to a depth of several feet or more over other materials. The soil derived from them, named Madias Silty Clay Loam, has potential value for agriculture.

During the early stage of erosion the Kootenay River, which is excavating its valley in this area, occupied the valley bottom at the elevation of its highest terrace. Before the river abandoned this elevation the Nestor and Madias fans contributed sufficient clay, mixed with river silt and sand, to form clay loam. The soil derived from these clay loam surfaced gravelly terraces was designated Narboe Clay Loam.

Elk River Valley

In the Elk River valley map-area the Rocky Mountains were over-thrust from west to east. Limestone and other rocks of Paleozoic age were thrust over younger Mesozoic formations, and valleys eroded in the fault lines. The Elk River has cut through the hard, older rocks and exposed the soft, younger formations beneath. The soft nature of the younger formations is probably a factor contributing to the size of this valley, which averages from one to four miles wide.

In stratigraphic succession the younger strata consist of the Jurassic Fernie beds and the Cretaceous Kootenay beds. The Fernie consists of soft yellowish brown shales and sandstones that were originally marine shoreline and deep water deposits and the Kootenay of soft, black coal bearing beds of continental origin. The strong colors of these formations were conveyed to the subsequent glacial drift and finally to the soils of the region.

The masses of till deposited in the main valley were contributed chiefly by tributary valley glaciers. These large concentrations of till occur at the mouths of tributary valleys, and cause the Elk River to meander around them and hold to portions of the valley sides having unbroken ridges.

* Geology of the Stanford Range of the Rocky Mountains, Kootenay District, British Columbia, by G. G. L. Henderson, Bul. 35, 1954, Department of Mines, Victoria, B.C.

Since the area of till now exposed was contributed largely from the side valleys, there is some variation of composition. The yellowish Fernie and black Kootenay formations supplied most of the till material. The till varies in color according to the amounts of yellowish or black substance it contains in different places. In some exposures the till is quite black, while in others it is yellowish brown with black and gray inclusions. The gray inclusions are probably due to glaciation of Paleozoic limestones at the higher elevations. No separation could be made according to color, but differentiation of the till was undertaken on the basis of reaction.

The till is calcareous in the area upstream from Hartley Creek, which is located about three miles northeast of Fernie. Between Hartley Creek and Morrissey the till is non-calcareous. The non-calcareous feature may be due to lack of limestone inclusion or to heavier precipitation in this area, which leached the lime away. The soil derived from the calcareous till was named Hosmer Clay Loam, and the soil derivative from the non-calcareous till was called Cokato Clay Loam. Both tills and the soils derived from them have loam to clay textures, the average being clay loam. Stone content is variable but moderate, the land being potentially arable where topography permits.

During the stage of ice retreat in the main valley, a considerable area above the mouth of Fording River was covered by an outwash of dark gray calcareous sand of medium texture. This material was probably deposited in a river delta where it entered a temporary glacial lake. The original deposit of sand was subsequently carved into a number of isolated parts by the down-cutting river. The soil derived from this material was named Crahan Sandy Loam.

After the Crahan sand had been laid down, silt and clay were deposited in ponded depressions. This process built up a silt loam over sand profile, and the soil which developed therefrom was designated Hornickel Silt Loam.

In the area between Brule Creek and the mouth of Michel Creek, the valley was occupied by a temporary glacial lake at the time when the Crahan sands were deposited. At this stage the mountain glaciers were contributing material from the higher Paleozoic formations, and very little of the underlying Fernie and Kootenay beds were being eroded.

The sediments deposited in the glacial lake are of moderate thickness over till. They consist of varved, gray, calcareous silts and clays, the textural range being from clay loam to clay, with an average clay texture. In subsequent time the Elk River carved a broad channel through this deposit and the underlying till, so that only a part of the original lake bottom remains. The soil derived from the several remaining segments of the old lake bottom was classified as Abruzzi Clay.

At a lower elevation a second glacial lake formed in the valley bottom between Coal and Morrissey creeks, southwest of Fernie. As in the case of the glacio-lacustrine area north of Natal, the Elk River has destroyed most of the lake deposit, and it is partly over-ridden by fans from the valley sides. Exposed areas of this lake bottom were also classified as Abruzzi Clay.

Around the margin of the glacial lake, between Coal and Morrissey creeks, sand kames formed along the valley sides during the melting of the valley glacier. On the north side of the valley parts of the kames are intact, whereas on the south they were eroded to form a lake beach. This material is non-calcareous, and the soil derived from it was named Wardrop Sandy Loam.

Since the close of valley glaciation the Elk River has been excavating a channel in the valley bottom. The till eroded by the river was sorted. The fine materials were carried away, and the sand, gravel and stones remained to form gravelly river terraces. The gravels and dark colored, calcareous sands of these terraces were finally capped by sand, silt and clay alluvium eroded from Hosmer till. The texture of the surface deposit ranges from sandy loam to clay, the average for the mapped area being sandy loam. The types of soil derived from these materials are dependent on the age of the terraces. The terrace soil type showing most profile development (Podzolized Gray Wooded) was named Sparwood Sandy Loam, the one having medium development (Gray Wooded) was called Cadorna Loam, and the soil type with the least development (Brown Wooded) was designated Michel Sandy Loam.

The bottom lands of the Elk River occupy considerable acreage throughout the mapped area. These are mostly second bottoms attached to the river banks, and a few scattered first bottoms in the form of midstream islands. The profile consists of a top stratum of fine-textured material overlying river gravel. The depth of the fine-textured surface layer varies from a few inches to six feet or more, with an average thickness of two and one half feet. The calcareous top stratum is noteworthy for its dark color, which serves to identify its origin as an erosion product of Hosmer till. The textural range in different places is from sandy loam to clay loam, the average being sandy loam. The name assigned to the type is Crowsnest Sandy Loam.

In addition to the soils derived from the products of glaciation, a number of alluvial fans were formed in places where temporary streams enter the main valley. The greatest number of fans occur between Natal and Morrissey, and the materials of which they are composed came chiefly from the Fernie and Kootenay formations. Some of the fans are derived from black material, while others are yellowish brown in color. There is also a difference of reaction, some fans being calcareous while others are weakly or not at all calcareous. To the north of Natal the fans are excessively stony, but downstream from this point the stone content is moderate. The range of soil texture is from loam to clay loam, the average texture being loam. The fans in the Elk River valley were assigned to the Wigwam Soil Complex.

Rocky Mountain Trench

The oldest unconsolidated deposit, which lies on bedrock, is the St. Eugene formation. It was described by Schofield* and Rice†, and is regarded by Rice as of Miocene age. The St. Eugene formation consists of gravels, sands and silts. It contains lignified vegetation produced in a climate similar to that of the southern United States. A new roadcut about a mile below St. Eugene Mission, on the north side of the St. Mary River valley, provides a convenient exposure of the St. Eugene strata. The exposed material consists of bluish gray, fine and very fine sands containing lignified vegetation. Some of this material has the appearance of volcanic ash. In this vicinity the St. Eugene deposit is directly overlaid by a few feet of fine, brown stratified sand, and this in turn is covered by from four to six feet of pebbly clay containing bits of the St. Eugene formation. Evidence that the pebbly clay is related to an early till occurs farther north.

Resting on the pebbly clay is 50 feet or more of stratified grayish white silty clay, dry, compact, calcareous and free of foreign material. This silty clay formation is exposed at a number of points between the border of Montana and Columbia Lake. The outcroppings, on bluffs of the Kootenay River and its tributaries within the Trench, range in elevation between 2,400 and 3,400 feet above sea level. The stratified silty clay deposit indicates a former lake that covered the bottom of the Rocky Mountain Trench in the mapped area, between the pre-Wisconsin and Wisconsin glaciations. Since the silty clay is not sufficiently exposed to be a soil-forming deposit, it was not named in this report.

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* Geology of the Cranbrook Map-area, S. J. Schofield, Memoir 76, 1915, Geological Survey, Ottawa.

† Cranbrook Map-area, H. M. A. Rice, Memoir 207, 1937, Geological Survey, Ottawa.

Wherever it remains in place, the stratified silty clay is overlaid by Wycliffe till, so named by Schofield. In this report the Wycliffe till is defined as the parent material of a group of soils called Plumbob, Wycliffe, Kinbasket and Flatbow. The Wycliffe till consists of a grayish white, loamy, strongly calcareous till containing grit, gravel, stones and boulders in varying amounts. It is hard when dry and tends to become soft when wet. The range of thickness is from a few feet to 50 feet or more. The Spillimacheen Glacier, which deposited the till as a broad band of limey material between Canal Flats and Montana, left areas of clearly defined south-pointing drumlins. These are located chiefly on the west side of the valley. Areas of modified and flattened drumlins occur on the east side and in the locality between the St. Mary River and Kimberley airport.

In the district between Canal Flats and St. Mary River, patches of weakly calcareous and non-calcareous till were derived from the Purcell Mountains. This type of till seldom extends into the Trench beyond the toe of the mountain slopes. An exception is in the St. Mary River valley where a greenish Purcell till extends downstream some distance below Wycliffe. This till is covered by outwash and its extent is unknown.

It is noteworthy that the streams from the mountain glaciers more or less ignored the present channel of the Kootenay River opposite their points of origin, but they swung into the Kootenay River channel farther south. In some cases the glacial river channels parallel the channel of the Kootenay River for many miles. It thus appears that in the decay stage of glaciation the Kootenay River channel in the Rocky Mountain Trench was to a variable extent occupied by ice, and was unable to receive drainage from east or west.

The bottoms of the glacial river channels, the terraces formed by tributaries, and the scattered terraces along the Kootenay River are composed chiefly of rounded gravels and stones. Inclusions of sand mixed with the gravel are rare, but silt mixed with the gravels can vary from silt-free gravels in the downstream areas to fairly high silt content near the tributary mountain coulees. The variable size of gravel and stones in the substratum indicates a fairly rapid rate of flow during the maximum stage of runoff. The gravels were finally surfaced by a thin coating of silt and very fine sand before the channels were abandoned, the average surface textures being loam and silt loam. A thin coating of loess is often found on the surface of these old alluvial deposits.

The soils which developed on these materials were separated into strongly and weakly calcareous groups, depending on whether the glacial river deposits eroded from Wycliffe till or non-calcareous materials from the Purcell Mountains. The latter are contaminated in places by small additions of eroded Wycliffe sediments.

The extensively distributed soils developed on the strongly calcareous gravelly river deposits were in some cases mapped as the Elko-Saha soils, and in other instances the two types were separated on the soil map. The Kayook series also developed on strongly calcareous materials, its distinguishing feature in comparison with the Elko-Saha soils being a thicker deposit of silty and very fine sandy material overlying the glacial river gravels. The soils developed on the weakly calcareous, gravelly, glacial river deposits have been named the Hyak series. This type has the same textured profile as the Elko-Saha Soils.

The limited sand content of the extensive area between Canal Flats and Montana is noteworthy. Either the bulk of the sands were transported into Montana, or very little sand was produced by glaciation of the sedimentary rocks in the two mountain systems. The Flagstone Sandy Loam is derived from the strongly calcareous medium to fine sandy deposits. The weakly calcareous sandy glacial river deposits occur chiefly in the valleys of Perry Creek and the St. Mary River, near the Purcell Mountains. They have finer texture than the calcareous sands and a more limited acreage. The soil developed on this material was called Oldtown Very Fine Sandy Loam. Most of the scattered areas of Flagstone and Oldtown soils have duned topography.

The amount of silt locally deposited in relation to the high silt content of the Wycliffe till is comparatively small. No doubt great quantities of silt were removed from the till during the stage of deglaciation that produced the gravelly glacial river channels, but the bulk of this silt was transported out of the district. Here and there the silts were trapped in temporary ponds or lakes at elevations ranging between 2,700 and 3,100 feet above sea level. In places the narrow remnants of silt deposits occur along the Kootenay River bluffs.

The silts are strongly calcareous, grayish white, stratified and free of organic material. Here and there thin layers of fine sand or gravel may occur. In thickness the silts range from a few feet to 50 feet or more, and they are underlaid by Wycliffe till. The soil developed on the strongly calcareous stratified silt was named Mayook Silt Loam.

The ice-filled Kootenay River valley received the drainage of the glacial river tributaries from south to north as it became sufficiently clear of ice to act as a drainageway. In the river trench the ice subsided slowly beneath a burden of outwash. At the same time the tributaries began to erode their post-glacial channels, which kept pace with the deepening valley of the Kootenay River. The eroded materials accumulated to form deltas that have become terraces at the mouths of most tributaries and for some distance downstream on the Kootenay River.

As the buried ice melted there was replacement by post-glacial outwash. Fans developed below the terrace level at the entry points of tributaries and the Kootenay River bed gradually filled up to its present elevation. The weakly to non-calcareous deposits at second bottom height produced soils similar to the Hyak series, but with shallower and younger profiles. These soils were mapped as the Lakit series.

In the same areas of outwash there are associated fine sandy materials to a depth of several feet over the gravels that underlie the Lakit soils. The weakly to non-calcareous soil type developed on these sands was named Kokum Very Fine Sandy Loam.

In post-glacial time the Kootenay River trench south of Canal Flats was lined with calcareous silt in the form of bottoms and floodplains. During the annual freshet the inundated areas still receive silt and clay from the Rockies, most of the clay being contributed from the area above Gibraltar Rock. The fine textured post-glacial deposits of the Kootenay River valley are as strongly calcareous as the Wycliffe till and the Mayook silts, hence there is a common origin based chiefly on the erosion of Paleozoic limestones. These river deposits became the parent material of a group of groundwater soils, which were mapped as the Salishan series.

After the glacier ice had vacated the Rocky Mountain Trench, at the time before vegetative cover became established, the region was exposed to storm and wind. Violent storms or "cloudbursts' brought materials down the valleys of temporary and small permanent streams, producing alluvial fans at the toe of the mountain slopes. Many of these fans still receive additions of material at the time of the annual freshet.

The fans occur along the valley sides, where the steep slopes begin. The materials of which they are composed vary with the kinds of rocks in each mountain valley. Some fans were eroded from limestones, while others weathered from non-calcareous rocks. To some extent each fan or group of fans differs in mineral composition. A detailed soil survey would differentiate the fan materials, and the soils derived from each kind of material would be classed as a soil unit or series. In this survey the bulk of thc fans were grouped as a complex of fan soils and mapped as the Wigwam Soil Complex. However, four fan types were differentiated and named Nestor, Madias, Lakit and Kokum series. These are separated members of the Wigwam Soil Complex.

Concurrently with the early fan formations, before extensive vegetative cover became established, areas in the bare Purcell Mountains were coated with non-calcareous rock flour having the texture of very fine sand and silt. The prevailing winds distributed this material as a thin coating of loess over most of the mapped area in the Rocky Mountain Trench. The greatest thickness of loess was observed on Wycliffe soils to the northeast of the St. Mary River wind-gap, in the vicinity of Skookumchuck Prairie and Lussier River (Sheep Creek). In this area the depth of loess ranges from several inches to a foot or more of light brown very fine sandy loam. The loess occurs to a depth of several inches on the Mayook soils in the vicinity of Rampart.

Over most of the mapped area in the Rocky Mountain Trench the loess coating is not easily identified, and it is generally confined to the first inch or two of the soil profile. There are greater accumulations in the hollows, due to downslope erosion. The loess helps to reduce the high lime content of the strongly calcareous soils, and may be regarded as an asset. The loess coating over the several soil types was not differentiated during the soil survey.

SOILS

Field Methods

This is a detailed reconnaissance soil survey, planned to include all land of agricultural value in the upper Kootenay and Elk River valleys. The soil survey was undertaken concurrently with a topographic survey, which supplied base maps after completion of soil survey field work. Aerial photographs were provided by the Water Resources Division, Department of Northern Affairs and National Resources, and by the Air Surveys Division, Department of Lands and Forests. The aerial photographs were used as field sheets, and the soils information was transferred to base maps as they came to hand.

Trucks were used as the base of field operations. Field parties worked from the trucks, the examination of soils and landscapes being done on foot. The nature of the soils was determined by examination of road cuts, cutbanks and by digging test holes. Attention was given to the native vegetation, topography, drainage and productivity of each soil type in relation to agriculture. From time to time, botanists, soil experts, geologists and others were invited to visit the field party and offer their advice in regard to the technical problems always encountered during pioneer soil surveys.

Soil samples were gathered from all soil types to determine average textures and reactions. After the mapping of soil types, profile pits were dug at selected virgin locations for soil type descriptions. Samples from some of these profiles were used for chemical analysis. All soil color descriptions are based on the Munsell Soil Color Charts.

In mountainous country the soil boundaries follow physical features, such as the toe of the mountain slope, the limits of a terrace or alluvial fan. Soil boundaries were accurately placed with the aid of air photographs and subsequent base maps having 20-foot contours.

Accurate base maps, supplied by the Department of Mines and Technical Surveys, cover the classified area between Gibraltar Rock and the border of Montana. Preliminary maps, developed from air photographs and Provincial Reference Maps, were used for the area between Gibraltar Rock and Kootenay National Park, and for the Elk River valley.

Soil Development

In the classified area the soil-forming materials consist of glacial till and derivatives of the till. Where exposed, the till is the oldest material on which soil development has taken place. The water-sorted derivatives of the till that comprise the terraces and fans are of different ages extending from the time of deglaciation to the present. Hence, the classified soil types have been developing for different periods of time.

Soil formation consists of weathering, which leads to profile development. The rate and intensity of soil development will depend not only on the climate and the biological factors, but also on the physical and chemical nature of the parent material, the topography, erosion and the length of time of weathering. Topography affects the exposure of the soil to the elements of weathering, and surface erosion may keep a soil in a state of perpetual immaturity. Atmospheric temperature and precipitation limit the type of vegetation and the degree of biological activity within an area. The amount of rainfall is one of the most important factors in soil development since it determines the amount of leaching that will occur in the soil profiles. The physical nature of the parent material sets the rate and depth of moisture penetration. Chemical properties of the parent material also influence soil development. In the mapped area there are soils developed on both highly calcareous and on comparatively lime-free materials. It has been observed that in this area soil development reached a more advanced stage on those materials that are lime-free than on those that are highly calcareous.

The poorest expression of soil development is found in the soils originating from highly calcareous parent materials in regions of low rainfall and high summer temperature. In the most arid sections of the mapped area, Dark Brown soils were formed where forest vegetation failed in competition with native grasses, particularly on south-facing slopes and where the parent materials are coarse textured and highly calcareous. Brown Wooded soils occur on heavier-textured materials where the available moisture is sufficient for minimal forest growth.

In the more humid sections of the mapped area, the fine-textured, calcareous soil types belong to the Gray Wooded soil group and some of the medium-textured calcareous soils belong to the Podzolized Gray Wooded soil group. Under the same climatic conditions, Brown Podzolic soils occur on coarse-textured, comparatively lime-free parent materials. Also found in the mapped area are fans and ground water soils in which soil development has been held to a minimum by the continual presence of a high water table or the frequent addition of fresh sediments.

The soil profile is the cross-section of that part of the soil mass used by plant roots. It contains a natural succession of layers or horizons extending downward into the parent material. The main divisions are called the A, B and C horizons, beginning from the surface. Taken together, the A and B horizons form the solum, or true soil formed by soil-building agencies. The C horizon is the parent material which lies in contact with the solum. If the solum is underlaid by geological material from which it was not derived, but which has significance to plant growth, the underlying material is designated horizon D.

The several divisions of the profile vary in response to the environment; factors being the time period of weathering, distinctions of temperature and rainfall, vegetation, drainage, chemical composition and texture. The variations are accounted for by subdividing the main horizons into A_1, A_2, A_3, B_1, B_2, etc., and describing the subdivisions that actually occur under different conditions. The depth of horizons varies and in some instances one or more sub-horizons may be absent. The mat of organic matter added to the surface by trees, shrubs, grasses and moss is designated horizon A_0. In poorly drained soils the horizon developed under the influence of groundwater is called horizon G.

Each well-developed soil horizon has a distinctive color, texture and structure. There is a wide range of soil colors under different conditions of climate, parent materials, drainage and stage of soil development.

Soil texture, which refers to particle size distribution of mineral material, has a strong influence on the whole profile. In young soils the texture of the horizons is generally the same as the texture of the parent material. As the soils develop a textural change often occurs in the A and B horizons, caused by downward movement of the finer particles and dissolved substances from the A horizon and their accumulation in horizon B. The soil particles have three main recognized groups—sand, silt and clay. A soil is usually composed of all three. The distinction known as soil class is arrived at by the relative proportions of these three separates which a soil may have. Soil structure refers to the manner in which the individual grains are arranged. The mechanical separates may be grouped into a variety of forms, such as crumbs, plates, granules and others.

Soil Classification

A soil survey involves the identification, mapping, description and classification of different kinds of soils that occur in a given area. Field classification begins at the level of the soil "series". A soil series is a soil derived from one kind of parent material, that occupies one drainage position. Usually the series has uniform topography, profile and other characters that make it stand out in comparison with other soils. The series is given a local name, and it becomes known by its name and texture and by the description in the soil survey report.

Where two or more series derived from one kind of parent material are not separated when the soils are mapped, the profiles and other characters of each series are described and the series are named in the usual way. The mapped groups are known by the soils they represent, such as Elko-Saha soils, and each series is described separately in the report. The series are divided into soil types according to the texture of the surface soil. Texture class names, such as loam, clay loam or silt loam, are added to the series name to give the complete name of the soil type, an example being Saha Silt Loam. Subdivisions of soil types important to agriculture are known as phases. Phases are based on such characters as topography, gravel and stoniness and are indicated on the map by appropriate symbols.

Soils may be excessively drained, well drained, or poorly drained, depending on the topographical position and the texture of the whole soil profile. Those derived from gravelly and sandy deposits in terrace positions have excessive drainage. Fine textured soils on slopes or terraces that are free from the influence of groundwater are well-drained soils. Poorly drained soils are those affected by groundwater, and in this report they are grouped under "groundwater soils".

The soil "complex" consists of a group of undifferentiated soils with at least one distinguishing feature in common. The common feature in regard to the Wigwam Soil Complex is that these soils have developed on a widely distributed system of alluvial fans. Aside from this relationship, the Wigwam soils have a variety of parent materials that occur under several conditions of climate and drainage. This complex is capable of separation into numerous soil series, textural classes and phases. Such differentiation, however, was not warranted during the present soil survey.

The probable origin of soil-forming deposits is outlined in the section under Geology of Soil Parent Materials. The relationship of the soil-forming deposits to the soil groups and series is shown in Table 3.

DESCRIPTION OF SOILS

1. Dark Brown Soils

The Dark Brown soils extend northward in the most arid locations from the 49th parallel to Skookumchuck Prairie. They occur as comparatively small, scattered areas of grassland, and more commonly, as a mixture of scattered trees and grass. The areas of grassland were differentiated as Dark Brown soils. The areas of mixed trees and grass were recognized as an intimate mixture of two soil types, the grassy part being a Dark Brown soil and the small patches of soil under the needle-mat of each tree were regarded as a forest soil type. Where Dark Brown soils are included with forest soils on the soil map as an undifferentiated group, the areas carry the names of both forest and grassland soil types, an example being Elko-Saha soils.

In a normal sequence from desert to forest, the Dark Brown soils occupy a position between Brown soils of the semi-desert and Black soils bordering the forest. In the Rocky Mountain Trench, however, there is only a slight shading of color on both sides of the Dark Brown soil group. On the dry side the lighter shade of brown is not of sufficient importance to warrant differentiation. On the humid side the soils range up to dark grayish brown, but cannot be classified as Black soils. The darkest soil color noticed in the mapped area is at Elko, where storms enter the Elk River valley, and the rainfall is greater than average.

The general characters of the Dark Brown soil profile as related to the mapped soils, are as follows:

Horizon	*Description*
A_1	Dark grayish brown with fine granular structure, from 3 to 7 inches deep.
A_3	Brown, granular, transitional horizon, sometimes absent, from 3 to 5 inches thick.
B	Brown to pale brown, structureless, 10 inches or more in thickness, sometimes divisible into sub-horizons.

In more or less lime-free soil-forming deposits the range of soil reaction is from pH 6·2 at the surface to pH 7·5 in the lower part of the solum. In limy parent materials the surface is from pH 6·6 to 7·0 and up to pH 9·0 in the sub-horizon of lime accumulation designated Bca. The division between A and B horizons is transitional and may be called A_3 or B_1 depending on the nearest relationship. Where two parent materials are mixed in horizon B, as in the case of gravelly terraces, this horizon is defined as horizon B-D.

The Dark Brown soils have been differentiated into three series. These are Plumbob Silt Loam, Saha Silt Loam and Hyak Sandy Loam.

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TABLE 3. CLASSIFICATION OF SOILS IN THE UPPER KOOTENTAY AND ELK RIVER VALLEYS

Glacial Parent Materials Strongly to Weakly Calcareous	Dark Brown soils	Brown Wooded soils	Gray Wooded soils	Podsolized Gray Wooded soils	Brown Podzolic soils	Groundwater soils
	Series	Series	Series	Series	Series	Series
Glacial Till	Plumbob — —	Wycliffe — —	Kinbasket Hosmer Cedrus	Flatbow — —	Cokato — —	— — —
Gravelly Glacial River Deposits	Saha Hyak —	Elko Kayook Michel	Cadorna — —	Sparwood Narboe —	— — —	— — —
Sandy Glacial Deposits	— —	Flagstone Oldtown	— —	Crahan —	Wardrop —	— —
Silt and Clay Glacial River and Lake Deposits	— —	Mayook —	Abruzzi Hornickel	— —	— —	— —
Post-Glacial Parent Materials Strongly to Weakly Calcareous						
Alluvial Fans	— — —	Wigwam Lakit Kokum	Wigwam Nestor Madias	— — —	— — —	Meadow — —
Floodplains and Second Bottoms	— —	— —	— —	— —	— —	Salishan Crowsnest
Organic Deposits	—	—	—	—	—	Muck

Plumbob Silt Loam

The Plumbob series consists of a group of Dark Brown soils derived from strongly calcareous glacial till. It occurs at from 2,600 to 3,500 feet elevation, the topography being from gently rolling and drumlinized to steeply morainic. The type is found on dry south slopes of drumlins and moraines in small, scattered areas to the south of Elko, around Cranbrook, and more extensively on St. Mary's Prairie, which lies near the valley of the St. Mary River. In these localities approximately 10,306 acres have been mapped.

The climax vegetation consists of bunch grass in more or less continual conflict with ponderosa pine. When the bunch grass is undisturbed the young pine seedlings are choked out soon after germination, but when this grass has been destroyed competition is reduced in favor of the pine, which may then invade the comparatively small areas of grassland. When overgrazed the sub-climax grasses consist of spear grass, downy brome and other secondary grasses and weeds which have poor pasture value.

The textural range is from loam to silt loam. Addition of silt and very fine sand to the solum by wind is more apparent than in the associated Wycliffe soils. The amount of loess in the upper part of the profile is expressed by the absence of stones that would otherwise be present, owing to the stone content of the underlying till. On St. Mary's Prairie, comparatively few stones have been removed from the land prior to cultivation.

The following profile was examined in the Indian Reserve northwest of Roosville, about two miles from the border of Montana. The profile is in over-grazed virgin soil, the cover being secondary grasses, weeds and scattered ponderosa pine. The topography consists of a gentle slope at the top of a drumlin where the solum has been thinned by down-slope erosion:—

Horizon	*Depth*	*Description*
A_1	0- 7″	Dark grayish brown (dry) silt loam. Fine granular structure, mellow, porous. Scattered gravel and stones. Scattered rodent burrows. Many grass roots. pH 7·0.
B	7-13″	Brown (dry) silt loam, granular, firm. Color shades to lighter brown with depth. Increased amount of stones and gravel. pH 7·7.
Bca	13-17″	Brown (dry) loam, massive, compact. Fine material mixed with fragments of till. Calcareous, lime plated stones. More stony and gravelly than horizons above. pH 8·2.
C	17″+	Very pale brown to white (dry) till. Loam texture, hard, weakly cemented, semi-impervious to water. Limey in the upper part. Rounded gravel, stones and boulders. pH 8·8.

A limited chemical analysis of this profile is shown in Table 6. The distribution of lime and phosphorus and the reaction are about the same as in the Wycliffe soils, the phosphorus being more evenly distributed. Exchangeable bases indicate similar latent fertility.

Agriculture

Some 20 farmers are cultivating about 2,000 acres or more of this type for wheat on St. Mary's Prairie, to the east of Kimberley. Grain growing began around 1905 and has continued on a marginal basis, the acreage tending to expand and contract with the price of wheat. The average yield amounts to about 15 bushels per acre, with smaller and greater returns depending on rainfall. While this soil type has promising latent fertility, dry farming is precarious owing to the climate.

Under irrigation the type of agriculture should be mixed farming with emphasis on dairy products and meats. Specialized cropping could be undertaken when profitable. The estimated farm duty of water is 30 acre inches, the irrigation season being from May 15 to September 15. Occasionally an earlier or later irrigation may be required.

In the classification according to suitability for irrigation, there are 827 acres of Second Class land and 7,576 acres in the Third Class, the total being about 8,403 acres of potentially irrigable land. There are also about 1,903 acres of morainic, non-arable land in this soil type, the latter being best suited for grazing.

Saha Silt Loam

The Saha series occurs as a group of gravelly soils which developed under grass on more or less flat bottomed glacial river channels and on terraces. The channels were excavated in the till-plain by streams of melt-water from retreating glacier ice. The terraces line the present channels of down-cutting streams, and also occur downstream from the points where they enter the Kootenay River. This type occurs between 2,400 and 2,800 feet elevation in the dry parts of the Rocky Mountain Trench, the topography being from gently undulating to gently sloping. About 10,057 acres of the Saha soils were differentiated to the south of Elko, near Cranbrook, on St. Mary's Indian Reserve and around Skookumchuck and Wasa.

An extensive, undifferentiated acreage covered with scattered trees and grass was mapped as Elko-Saha soils. The Saha soils in the Elko-Saha group have the same profile as the Saha Silt Loam described in this section. The Saha soils support an easily overgrazed climax growth of bunch grasses. In all areas of the type the climax grasses have been replaced by spear grass *(Stipa comata)* and other secondary grasses and weeds. The second growth is scanty and the pasture is of poor quality.

The Saha Silt Loam developed from the same parent material as the Elko soils. Noteworthy differences of the Saha profile are the thinner solum, the higher content of organic matter in the solum and the layer of lime-cemented gravel that lies beneath the silty topsoil. While to some degree porous, the foot-thick layer of lime-cemented gravel checks the downward movement of irrigation water and reduces water losses. The cemented layer may eventually decompose under irrigation.

The following is a description of the Saha soil profile, located about two miles southwest of Elko, on a virgin site with bunch grass cover. The topography consists of a gentle slope with a smooth surface:

Horizon	*Depth*	*Description*
A_1	0-3½"	Dark grayish brown (dry) loam to silt loam. Fine granular structure, friable, porous. Scattered gravel up to one inch diameter. Scattered stones and boulders. pH 6·6.
A_3	3½- 7"	Brown (dry) loam to silt loam containing grit and gravel. Compact, granular, porous, many grass roots. A transitional horizon. pH 6·7.
B-D	7-17"	Light brownish gray (dry) finely granular loam, compact and gravelly. Gravel content and scattered stones increase with depth to a concentration in the lower part. Free carbonate at 10 inches. pH 7·5.
Dca	17-28"	Whitish gray (dry) lime cemented gravel and scattered stones. Hard when dry. Small amounts of limey silt. Crusty and semi-impervious. pH 8·4.
D	28"+	Gray (dry) stratified medium gravel and scattered stones. Lime plated stones in the upper part and at various depths. Gravel of variable thickness resting on glacial till or older deposits.

The reaction in the above profile is slightly lower than average, owing to parent material variation or greater than average rainfall. Total phosphorus and the distribution of this element in the profile compares with the Plumbob series, but in practice the Saha soils are known to give a noteworthy response to applications of phosphate and nitrogen fertilizers.

Agriculture

In its natural state this type is suitable only for use as range. The range is poor in the greater part of the area, where the bunch grass has been destroyed and replaced by annual grasses and weeds.

Under irrigation the Saha soils should only be used for sod crops which require minimum cultivation. Owing to the high porosity of the subsoil, irrigation water must be flumed or piped to the land. Sprinkler irrigation probably will be necessary and light applications are recommended. The farm duty of water is high, being estimated at about 4 acre feet.

In the classification of soils according to suitability for irrigation, Third Class land amounts to 1,639 acres, Fourth Class 8,238 acres and Fifth Class 180 acres.

Hyak Sandy Loam

This series is composed of a group of gravelly soils developed on more or less flat bottomed glacial river channels and on terraces. The mode of formation is the same as that of the Elko-Saha soils, but the parent materials came from a source where limestones were not abundant. The most extensive areas lie to the east of Kimberley and at the mouths of tributary streams farther north, which drain from the Purcell Mountains. In this locality the Purcells consist largely of sedimentary rocks which do not include large areas of limestones.

The range of elevation of the Hyak type is from 2,600 to 3,500 feet above sea level, and the total area mapped amounts to about 13,486 acres. The channel bottoms and terraces surfaced by this group of soils are excessively drained, and they lie above the present runoff elevations. The topography has two phases, the most general topography being undulating to gently sloping. Minor river channel areas are pitted with kettle holes.

The soil textures range from sandy loam to silt loam, the average texture being sandy loam with the fine and very fine grades of sand most common. The amount of stones and boulders in the surface soil is variable, and generally dependent on the amount of this material in the D horizon. Gravel at the surface is most abundant where it was heaved up by the roots of falling trees. In areas of grass a certain amount of gravel has been brought up and scattered in the surface soil by burrowing rodents.

The parent materials consist of gravels and silts carried by melt-water and deposited during the retreat of the valley glaciers. The melt-water excavated channels in the previously deposited till-plain. Most of the gravel flooring in the channels appears to have been introduced from the Purcell Mountains.

A fine-textured capping from 12 to 14 inches thick covers the gravelly and often stony river deposits. This was supplied before the channel bottoms were abandoned. The gravel of the channel bottoms is of variable but generally unknown thickness, underlaid by impervious glacial till. The chief textural characteristics of the Hyak soils are a surface capping of sandy loam to silt loam over a substratum of gravel. In this respect the Hyak soils are the same as the Elko-Saha soils. The gravel is generally rounded, of medium size and it may have a variable silt and sand content; included stones and boulders are a variable factor. In some places stoniness is excessive.

While this type has been mapped as a Dark Brown soil, the mapped area contains marginal conditions of scattered trees and grass and occasional groves of trees, hence there is an included forest type capable of differentiation. With more detailed field work the areas of soil beneath groves of trees could be separated and described as a Brown Wooded soil.

The Hyak series is a Dark Brown soil on which bunch grasses were originally dominant. The growth of bunch grasses was stronger than on the Saha soils, but with overgrazing the original grasses have been replaced by secondary grasses and weeds of lower feeding value. A profile in natural grassland was examined on St. Mary's Prairie to the east of Kimberley. It is located in an old channel of Cherry Creek which at one time crossed St. Mary's Prairie and entered the St. Mary River between Wycliffe and Marysville. This profile is described as follows:

Horizon	*Depth*	*Description*
A_1	0- 5″	Dark brown (dry) sandy loam; weak crumb structure, porous, friable, scattered stones and gravel. pH 6·2.
A_3	5-10″	Brown (dry) sandy loam, weak crumb structure, porous, friable, scattered stones and gravel. pH 6·5.
B-D	10-16″	Brown (dry) sandy loam mixed with stones and gravel, structureless, slightly compact. pH 6.5.
D	16″+	Brownish gray (dry) stratified gravel, stones and boulders, the bulk being medium sized and small gravel. Lime plated stones at 18″ depth. The depth of this stratum is six feet or more, with glacial till or earlier deposits beneath. The same type of formation as the D horizon of the Elko-Saha soils but less calcareous. pH 7·5.

Agriculture

In the natural state the Hyak soils are suitable for range, but the range requires management in order to avoid overgrazing and the replacement of nutritious grasses with weeds and secondary grasses of low feeding value.

Under irrigation the soils are capable of limited use, chiefly for sod crops. Cultivation should be kept to a minimum, owing to the thin solum. Tilled crops, such as potatoes and vegetables would not be easily produced, except in areas with a deeper than average solum.

With irrigation the type of agriculture should be mixed farming, the land being divided so that a part of the farm acreage would include another soil type if possible. The farm duty of water for the irrigation season is about 3 acre feet. In order to avoid considerable losses, the irrigation water should be piped or flumed to points of distribution. Land reclamation includes the removal of scattered trees and stones, the latter being the greater job. The most suitable method of development would be to reclaim the least stony areas, and gradually bring in lands of lesser value.

In the classification according to suitability for irrigation, there are 391 acres of Third Class land and 3,795 acres of Fourth Class land. In addition there are 1,323 acres of Fifth Class land of dubious value for irrigation under present economic conditions. The remainder consists of 7,813 acres of excessively stony land, and 163 acres of land that is badly kettled, both of the latter types being non-arable.

2. Brown Wooded Soils

In the Rocky Mountain Trench, between Montana and Canal Flats, the soil parent materials are chiefly calcareous and the summer is very dry. Under these conditions the south-exposed areas of the more drought-resistant soils, and the excessively drained soils, developed under natural grassland as Dark Brown soils. On slightly more shaded slopes, in storm tracks and at higher elevations, the grasslands merge with forest. Along the boundary fringe of grassland this takes the form of scattered trees and grass, which passes with increasing numbers of trees to semi-open forest. These are minimal conditions for forest growth in competition with grassland, hence the soil profile is comparatively undeveloped. The soils that occur in this marginal environment are regarded as Brown Wooded soils, the main characters of the soil profile being as follows:

Horizon	*Description*
A_0	A thin layer of forest litter from one-half to one inch thick.
A_1	Dark grayish brown, from one to three inches in thickness, sometimes absent.
A_2	Pale brown to light gray. A weakly developed, platy horizon from one to three inches thick.
B_1	Pale yellow to pale brown transitional horizon from four to twelve inches thick. Sometimes absent.
B_2	Pale yellow to brown weakly blocky horizon from three to twelve inches in thickness. Slight accumulation of colloids, non-calcareous.

In highly calcareous parent materials, where the Brown Wooded soils are most commonly found in the mapped area, free lime has been removed from the surface 6 to 8 inches. To these depths the soil is nearly neutral, the reaction being from pH 6·6 to 6·8. In the limey horizon below, designated Bca, the reaction can range from pH 8·0 to 9·0. A high reaction in horizon Bca is found in soils derived from calcareous till. The carbonates of lime and magnesia are the only constituents that show observable downward movement in the profile. There is little evidence that colloidal clay, iron and alumina move downward as in the case of Gray Wooded soils.

The Brown Wooded soils were separated into 9 series named Wycliffe Silt Loam, Elko Silt Loam, Mayook Silt Loam, Oldtown Very Fine Sandy Loam, Flagstone Sandy Loam, Kayook Silt Loam, Lakit Sandy Loam, Kokum Very Fine Sandy Loam and Michel Sandy Loam.

Wycliffe Silt Loam

This series consists of a group of stony soils derived from strongly calcareous glacial till. The soils are distributed on a morainic and drumlinized till-plain in the Rocky Mountain Trench, between Canal Flats and the border of Montana. The lowest surface elevation of the type is along the Kootenay River in the southern part of the area at about 2,600 feet above sea level, and the highest areas mapped are at about 3,500 feet elevation. Between these two elevations the area of Wycliffe soils amounts to about 213,000 acres.

Originally the till-plain was a more or less continuous covering over the floor of the Rocky Mountain Trench. As the ice retreated, however, it was modified into uplands of morainic and drumlinized till separated from one another by glacial river channels, glacial lake deposits, post-glacial valleys of tributary streams and the channel of the Kootenay River.

The drumlinized topography varies from rounded hills with steep north and lateral slopes to rounded hills with moderate slopes in all directions. Areas of moraines also accur, some being of great size, that have medium to gentle slopes, while other areas consist of steeply sloping ridges. The comparatively narrow depressions between drumlins and moraines are drainage-ways and sometimes natural basins containing widely spaced pot-hole sloughs and small lakes.

The soil textures are mainly loam and silt loam, with occasional small areas of very fine sandy loam. Addition of silt and very fine sand to the solum by wind action has occurred in the past. The amount of loess varies from a thin, scarcely observable mantle to a foot or more of stone-free soil.

The chief soil limitations to cultural practice consist of stoniness and topography, and the many soil areas of the type are graded accordingly. In different places the amount of gravel, stones and boulders varies from scattered gravel and a few stones to excessive quantities of gravel, stones and boulders on the surface and in the soil profile. Excessive gravel and stones occur in areas where the surface of the till has been subject to weathering and removal of the fine materials which form the bulk of the till.

The parent till that underlies about 18 inches of weathered soil is of loamy texture and grayish white in color. The coarser grades of sand are represented in remarkably small amounts, indicating a till derived from fine-textured rocks. The loamy material is studded with gravel, the main sizes being from one to three inches in diameter. The larger stones and boulders are scattered in the till mass. The till is hard when dry and on exposures it is soft when wet. The depth of the till stratum varies from a few feet to 100 feet or more in different parts of the mapped area. The underlying strata consists of interglacial deposits, and till and outwash of earlier glaciations and bedrock.

The native vegetation consists of a semi-open forest of ponderosa pine and fir, with larch and lodgepole pine in the more humid locations. Aspen and willow grow at high elevations and in the damp hollows between ridges and drumlins. Antelope bush, saskatoon, waxberry and pine and other grasses take over at the lower elevations after fires.

The Wycliffe soils are well-drained, the underlying till being hard and dry. It would appear that the runoff in spring occurs over frozen ground and that the greatest wetting of the profile takes place in the month of highest rainfall. Downward saturation penetrates from 9 to 16 inches, moving the lime into horizon Bca, but there is little accumulation of marly lime in hollows due to down slope leaching. A reaction of pH 8·7 to 9·0 in the lower part of the solum is noteworthy, particularly when alkali accumulations are absent.

A profile was examined to the southeast of the Elk River bridge near Waldo, at the toe of a gentle drumlin slope, where erosion from above could thicken the solum. The profile site is located on the soil map. The profile pit was dug near a group of ponderosa pine. This is described as follows:

Horizon	*Depth*	*Description*
A_0	½- 0″	Brown (dry) forest litter, needles, twigs, grass, thin patches of moss. Decomposed in the lower part.
A_1	0- 2″	Dark grayish brown (dry) silt loam, platy, porous. pH 7·0.
A_2	2- 3″	Grayish brown (dry) silt loam, platy, no stones or gravel. pH 7.0.
B_1	3- 9″	Very pale brown (dry) silt loam, weakly blocky, porous, no stones or gravel. pH 7·1.
B_2	9-17″	Yellow (dry) silt loam, blocky, slightly heavier than horizon above, scattered stones. pH 7·4.

Horizon	*Depth*	*Description*
Bca	17-36"	Very pale brown (dry) loam, gritty soil material mixed with small bits of till. Gravelly, stony, scattered boulders. Fluffy but firm, root mat at the bottom, very calcareous. pH 8·7.
C	36"+	White (dry) loam textured weakly cemented till, containing variable amounts of stones and gravel. Hard, semi-impervious to water, very calcareous in zone of contact with the solum. pH 9·0.

Limited chemical analyses of this profile, shown in Table 6, illustrates the distribution of lime and phosphorus. Under forest the soluble calcium has been leached to a depth of 17 inches. Below this depth there is a remarkable increase of lime content and reaction, without any marked change of soil color. The high total calcium is accompanied by low total phosphorus. The total P_2O_5 in other agricultural districts of British Columbia averages 0·22 per cent for the whole profile, compared with 0·14 per cent here. There is evidence that phosphorus is available during the damp season and unavailable under dry conditions.

Exchangeable bases are high for silt loam. They compare favorably with similar analyses of clay loam and clay soils of other regions. Total boron content amounts to 67 parts per million in the first 14 inches, the available fraction being 2·3 p.p.m. When water is applied to the Wycliffe soils the response leaves no doubt as to their latent fertility.

Agriculture

The present use of the Wycliffe soils is for forest and forest-range. The high lime content of the soil appears to emphasize the effect of the summer drought, hence growth is slow and stunted. The mature timber has been logged. Production of a new crop of commercial timber is made doubtful by the time it would take and the fire hazard. However, the conditions are satisfactory for the production of Christmas trees, and suitable areas are being developed for this purpose.

Where topography is favorable and surface stone not excessive, the Wycliffe soils are suitable for irrigation. The farm duty of water is about 30 acre inches for an irrigation season extending from about May 15 to September 15. Pasture from non-irrigable land should not be regarded as an asset when the size of the farm unit is determined, because such acreage would decline in range value. There should be emphasis on dairying and the production of beef. Specialized crops may be regarded as a sideline to be undertaken when profitable.

Before irrigation and cultivation the land requires clearing of forest and removal of stones and boulders. Since the forest is comparatively light, and large areas are burned or logged clear, the removal of trees, stumps and brush is not expensive in most localities. The stones require periodic removal.

When the land is first cultivated under irrigation, the soil organic matter should be increased and mineral fertilizers will be required. Availability of certain trace elements may be reduced by the strongly calcareous parent materials, causing mineral deficiencies in plants when the land is cropped.

Soil fertility and crop production will increase under irrigation when soil deficiencies have been satisfied and the best crop varieties for the climate are selected. Sprinkler irrigation is recommended, with applications every two weeks or as required during the irrigation season. The Wycliffe soils will be economical with water, owing to the impervious substratum. Excessive applications of water will cause saturation of the solum and seepage at the toe of the slope.

There is little possibility of finding well water under the Wycliffe soils, owing to the impervious nature and thickness of the till and the well-drained topography. Cisterns will be necessary for the storage of domestic water when the irrigation system is not in operation. Where the till is thick and compact the water loss is low and cisterns with no linings may be possible. Water for stock can be stored by ponding depressions between drumlins, or by dugouts that can be filled with irrigation water.

Under the classification of soils according to suitability for irrigation there are 20,309 acres of Second Class land, 64,627 acres in the Third Class and 399 acres in the Fourth Class of irrigable land. The total irrigable area of the Wycliffe soil type amounts to about 85,275 acres.

Elko Silt Loam

The Elko series developed in more or less flat bottomed glacial river channels and on terraces. The channels were carved through the till-plain by streams of melt-water from decaying glacier ice. The (Brown Wooded) Elko soil type is combined with the Saha series where the native vegetation consists of scattered trees and grass, and groves of trees surrounded by scattered trees and grass.

The areas of greatest extent lie to the west and south of Elko, where a great outwash has reduced and flattened a large part of the former till-plain. Other extensive areas lie between Bull River and Fort Steele, and in the vicinity of Skookumchuck and Wasa. These soils also occur on terraces bordering the Kootenay River, near entry points of tributaries.

The range of elevation is from 3,400 feet above sea level along the toe of the mountain slopes to 2,400 feet in the vicinity of the 49th parallel on the Kootenay River. Between these two elevations there are about 80,000 acres of Elko-Saha soils. In all cases the channels and terraces surfaced by Elko-Saha soils are excessively drained, and lie well above the present level of runoff.

The topography was mapped in three phases. The most general topography is undulating and gently sloping. However, there are about 891 acres of rough broken land and approximately 12,870 acres containing kettle holes, of which about 7,325 acres are non-arable. In addition 6,677 acres are excessively stony.

The undulating and gently sloping phase is the most suitable for agriculture. The kettle phase consists of river channels pocked with kettle holes and a few pitted terraces. The kettles may be close together or far apart, their size and depth being variable. Stones, boulders and forest growth are all more abundant on the kettle phase, and the depth of soil is greater than in the undulating and sloping areas.

The soil textures vary from loam to silt loam, the latter being the most common, and there are small scattered areas of sandy loam. The amount of stones and boulders in the surface soil varies within wide limits. Gravel at the surface is most abundant where it was heaved to the surface by the roots of falling trees.

A capping of silt, clay and very fine sand from 12 to 14 inches thick covers the gravelly and often stony river deposits. This was supplied in part by the erosion of drumlins and partly from the melting ice during the freshet season, before the channels were abandoned. Similarly, the gravelly terraces of the Kootenay River were formed by the outwash of tributary streams.

The gravel of the channel bottoms is of variable but generally unknown thickness, underlaid by glacial till impervious to the downward movement of water. The occurrence of porous gravel with an impervious stratum beneath affords a drainage level for runoff water. Springs of remarkable size are found where the underground water comes to the surface.

The chief textural characters of the Elko soil profiles are the surface capping of fine texture over a substratum of gravel. The rounded gravel is of medium size, most of it an inch or less in diameter, and this gravel may have a moderate silt content for the first foot or two in depth before it becomes clean. Included stones and boulders are a variable factor. In some places stoniness is excessive.

While the gravelly substratum is composed of clean stratified, coarse material over the greater part of the classified area, there are a few terraces and channels that contain a substratum of gravel liberally mixed with silt and very fine sand. These old drainage-ways are generally located near the mountains, and while the more silty substratum improves the agricultural value of the land, it could not be differentiated during the present survey.

Included with the Elko soils is a mixed soil found in limited areas from 100 to 300 feet wide and of varying length, where drumlins of silty till form the walls of former river channels. This is an erosion product spreading from the toe of the slope. The silt has eroded from the till and covered the Elko profile. Sometimes there is a narrow wash of this material down the side of a channel for some distance. The result is an improvement of the Elko soil; there is more drought resistance and a larger volume of growth.

There are several degrees of moisture distinction expressed by the variation of tree species. In areas of scattered trees and grass the ponderosa pine indicates dryness, whereas fir, larch and lodgepole pine are found at the higher locations and on slighty more humid or drought-resistant sites. The different species and their density of growth reflect soil moisture conditions due partly to an increased thickness of the fine-textured solum and in part to areas favored by the most rainfall. Where the forest has been destroyed, the antelope bush, along with a few other shrubs and grasses, appear to be the sub-climax growth.

The following profile of the Elko soil type was examined in an area of virgin soil. The cover is young fir and scattered ponderosa pine, the ground layer being antelope bush and pine grass. The location is a mile north of Edwards Lake, near the main road. The layer of lime-cemented gravel (Dca) found in the Saha soil profile is absent, but there is a layer of lime plated gravel:

Horizon	*Depth*	*Description*
A_0	1- 0″	Dark brown partly decomposed and well decomposed organic matter, needles, twigs, grass, etc.
A_1	0- 1″	Very dark gray (dry) silt loam, granular, gravelly, porous. pH 6·8.
A_2		Light brownish gray (dry) silt loam, granular. An indistinct layer one eighth to one quarter inch thick, not continuous.
B	1-13″	Yellowish to pale brown (dry) silt loam containing fine gravel, medium gravel, stones and scattered boulders. Granular, mellow, porous, root mat in the lower part. pH 6·1.
B-D	13-27″	Light yellowish brown (dry) to pale brown. Silt loam in a matrix of gravel, stones and scattered boulders. The silt content is sufficient to affect moisture relations. Granular, porous, penetrated by roots; lime-plated gravel in the lower part. pH 8·4.
D	27″+	Brownish gray (dry) stratified gravel, stones and boulders, the bulk being medium sized and small gravel. This stratum is of variable depth, generally more than six feet, and underlaid by till or earlier deposits.

The total phosphorus in this profile compares with the phosphorus content of the Wycliffe soils, indicating that the Wycliffe till is the chief source of the parent material.

Agriculture

Without irrigation the Elko soils are suitable only for forest and forest-range. Under irrigation the type has agricultural value for limited use, chiefly for sod crops. Cultivation should be kept to a minimum, owing to the thin solum. Tilled crops, such as potatoes and below-surface vegetables should not be produced. Above-ground vegetables may be grown in limited areas of deeper than average solum.

Under irrigation the type of agriculture should be dairying and beef production, with the land subdivided so that part of the acreage may include another soil type. The farm duty of water is approximately 44 acre-inches. Irrigation water must be flumed or piped to points of distribution.

The Elko soils would increase in fertility as the preliminary deficiencies are overcome. The content of organic matter in the soil should be increased and maintained as a means of holding water and getting the best yields. Complete fertilizers are required at the beginning of cultivation in order to start the first crop.

Irrigation would increase the volume of water in underground streams which have outlets in the form of large springs. Some of these underground supplies may be tapped by wells, but the majority of farmers would have to rely on concrete cisterns for the domestic water supply when the irrigation system is not operating. The irrigation of the Elko soils would create an underground storage seeping back into the Kootenay River, and to some extent this would help to even the river flow.

Land clearing for cultivation includes removal of the light forest and stones, the latter being the biggest job. The shallow rooted trees and the stones could be handled in part by land clearing machines. The most likely method of development is to settle the least stony soils first, and gradually bring in more stony areas, as the land increases in value.

Under the classification of soils according to their suitability for irrigation, there are about 2,967 acres of Third Class Elko-Saha soils, 39,708 acres in the Fourth Class and 22,483 acres in the Fifth Class of irrigation land.

Mayook Silt Loam

The Mayook Silt Loam developed on strongly calcareous lacustrine and glacial river silts in the mapped area. The stratified silts occur to the north of Jaffray along the Kootenay River and its tributaries. Some of the separated areas were formed in ponds, while others were old floodplains. Areas of the type range in elevation from about 2,700 to 3,000 feet above sea level. The total area mapped amounts to approximately 11,694 acres.

The topography varies to a considerable extent. The general surface relief is gently sloping to gently undulating, and of this type there are about 9,000 acres. The silts erode easily, and where banks are exposed the deposits are gullied and destroyed. About 1,280 acres have been reduced to rough broken land of no value for cultivation. Several areas, amounting to about 2,424 acres, are pocked with kettles and these have been classified as a kettle phase of topography.

The soil texture is chiefly silt loam, but there are small areas of loam that have not been differentiated. The loam texture is due to slight variation of the parent material and in some cases to a surface capping of loess from one to several inches thick in different places.

The parent material consists of well-bedded whitish, stratified silts, mostly of silt loam texture.. In some places the silt content is very high. These silts are strongly calcareous, the CaO content being up to 15 per cent or more. The stratified silts range from a few feet to 50 feet or more in thickness, and they are underlaid chiefly by the Wycliffe till.

The series is a forest soil type, but a few areas of mixed trees and grass occur. The vegetation consists of semi-open stands of ponderosa pine, fir and lodgepole pine, with an undercover of snowberry, rose, antelope bush and grass. The Mayook soils are well-drained and the native growth is stunted by the dry summer and the high lime content of the soil.

The soil has a neutral reaction to a depth of about 7 or 8 inches. This may be due partly to the downward movement of moisture and in part to a thin surface covering of non-calcareous loess. The balance of the profile receives a limited amount of moisture and the parent material is dry the year around.

A profile was examined about a mile south of Rampart, near the main highway between Cranbrook and Wardner. This is described as follows:

Horizon	*Depth*	*Description*
A_0	1- 0″	Brown forest litter; needles, twigs, etc. at the top. Decomposed to dark brown material in the lower part.
A_1	0- 1″	Very dark brown (dry) silt loam, fine crumb structure. Many feeding roots. pH 7·0.
A_2	1-2½″	Pale brown (dry) silt loam. Weakly platy. pH 7·6.
B_2	2½- 7″	Pale brown (dry) silt loam. Crumb structure, compact but friable. pH 7·6.
B_{3ca}	7-11″	Very pale brown (dry) angular silty nodules up to ¼″ in diameter scattered in soft calcareous silt loam, the nodules becoming hard with depth. pH 8·5.
B_{4ca}	11-17″	White (dry) silt loam, subangular blocky structure up to 1″ diameter, the structural units containing clay. Compact, strong reaction. Root mat at the bottom of horizon. pH 8·8.
C	17″+	Light gray (dry) finely banded silt loam, calcareous, no stones or gravel. Stratified material up to 50 feet or more in depth. At 17″ the reaction is pH 9·3.

The chemical analysis of the above profile illustrates a feature not always apparent on field observation. At an early stage of deglaciation, the soils in some parts of the Rocky Mountain Trench were coated with non-calcareous loess. In the Mayook soil profile, the analysis indicates that the top 7 inches is composed chiefly of loess, with the Mayook silt below. The difference in the content of SiO_2, Al_2O_3, CaO, MgO, K_2O and Na_2O in the upper and lower parts of this profile is noteworthy. The mineral content of the upper part compares with that of the solum of the Oldtown Very Fine Sandy Loam, described elsewhere in this report. While this may be called a mixed soil, the loess coating is not a mappable distinction, particularly on the scale of the present survey.

Agriculture

The present use of the Mayook soils is chiefly for forest-range and forest. The high lime content of the soil emphasizes the effect of drought, hence the growth is stunted and the limited grass is easily overgrazed.

Dry farming was observed on the Mayook soils between the St. Mary River and Cranbrook, where several settlers grow low yielding crops of grain. The dry farming of these soils is not recommended, and no further settlement for this purpose should be undertaken. Where small blocks are irrigated, up to 4 tons of alfalfa per acre are obtainable from two cuttings, and subsequent growth is used for pasture.

It is evident that these soils are suitable for irrigation and the type of agriculture should be mixed farming. Legumes and hay, potatoes and cool season vegetables could be produced. The farm duty of water is approximately 30 acre-inches. Owing to the ease with which this type will erode, sprinkler irrigation is recommended, with applications every two weeks between May 15 and September 15 or as required.

Land clearing of the medium open forest can be undertaken by machinery. When the land is first cultivated an increase in the organic matter of the soil is an objective. The first crop should be well fertilized, and thereafter the production of sod crops will help to get the land in shape.

There is little or no possibility of finding well water, owing to the topographic position of most areas of the type. Under these conditions, cisterns will be necessary for the storage of domestic water and water for stock when the irrigation system is not in operation.

Under the classification of soils according to their suitability for irrigation, there are 6,097 acres of Second Class land, of which about 954 acres are moderately kettled. In the Third Class there are approximately 4,242 acres, of which 1,395 acres contain scattered kettles. Only 75 acres of this type were graded as Fourth Class land.

Oldtown Very Fine Sandy Loam

The Oldtown series developed from weakly calcareous to non-calcareous rock flour, derived chiefly by glacial erosion of rusty weathering argillites of the Creston Formation. These are sedimentary rocks of pre-cambrian age, extensive areas of which are exposed in the southern part of the Purcell Mountains.

This type occurs in the mapped area on the south side of the St. Mary River, in the general vicinity of Perry Creek, which appears to have contributed most of the parent material, and there is a small area to the south of Kimberley. The fine and very fine sands were laid down as river deposits during deglaciation, at elevations between 3,000 and 3,500 feet above sea level. This is a minor soil type, with a total of about 3,084 acres in the mapped area. The topography is gently sloping and duned in separated areas.

The parent material consists of weakly calcareous to non-calcareous pale brown fine to very fine sands of variable thickness, which overlie older deposits. The underlying strata may be white stratified sands, greenish weakly calcareous Purcell till, limey Wycliffe till, Mayook silts or stratified gravel.

The native vegetation is composed of open stands of fir, larch, lodgepole pine, ponderosa pine, aspen, willow and juniper. There is a scanty undercover of antelope bush, a few other shrubs and pine grass.

The soil has pinkish colors near the surface, becoming pale brown with depth. The pale brown color is believed to be partly inherited from the parent material. Since the Oldtown soils occur in comparatively small, scattered areas there is some profile variation. This is due to the variable thickness of parent material overlying other deposits, and to differences of elevation and humidity.

A profile was examined about three quarters of a mile south of the Wycliffe bridge across the St. Mary River, in an area bordering Mayook silts, where the parent material is comparatively thin. This is described as follows:

Horizon	*Depth*	*Description*
A_0	1- 0″	Dark grayish brown forest and grass litter. Needles, twigs, leaves and grass.
A_2	0- 1″	Pinkish white (dry) very fine sandy loam, weakly platy, porous, uneven, pH 7·0.
A_3	1- 4″	Pink (dry) platy very fine sandy loam. Friable, porous, no stones or gravel. pH 7·6.
B_2	4-16″	Very pale brown (dry) very fine sandy loam, weak blocky structure, porous, mellow, slightly compact. No stones or gravel. pH 7·2.
B_3	16-22″	Very pale brown (dry) very fine sandy loam, massive; scattered light yellowish brown (dry) soft concretions. pH 8·3.
C_{ca}	22″+	White (dry) stratified very fine sandy loam, calcareous, no stones or gravel. pH 8·9.

The unusual feature in this profile is the C_{ca} horizon, which shows contamination of the very fine sandy parent material by limey sediment at the time of deposition. Beneath the C_{ca} horizon there are stratified layers of calcareous very fine sand, separated by layers of the same material that are not calcareous. This is not due to seepage. It is apparent that rock flour derived from non-calcareous Purcell rocks was alternated to some extent with erosion from Wycliffe till when these materials were deposited in a temporary lake or pond.

The Oldtown Very Fine Sandy Loam is low in nitrogen and organic matter, and there is an exceptionally high percentage of silica. The iron content is fairly low, and there is indication of a slight downward movement of iron. The analysis shows comparative abundance but little displacement of the alkali earth metals.

There is an area on the main road between Kimberley and Kimberley Airport, consisting of about 71 acres of duned topography. While the parent material is similar to that of the Oldtown series, the climate is more humid and the elevation is 3,530 feet above the sea. This area is included with the Oldtown series, owing to its small size, but in a future soil survey it should be differentiated as a separate soil type. The soil profile, which shows Podzolized Gray Wooded soil development, is described as follows:

Horizon	*Depth*	*Description*
A_0	½- 0″	Forest litter composed of leaves and grass.
A_{2p}	0- ½″	Brown (moist) sandy loam, weakly platy, fluffy, breaking to single grain structure, porous. pH 6·1.
B_{2p}	½-1½″	Dark yellowish brown (moist) loamy sand, weak subangular blocky structure, porous, friable, no stones or gravel. pH 6·6.
B_{3p}	1½- 4″	Yellowish brown (moist) loamy sand, weak subangular blocky structure breaking to single grain structure, porous, no stones or gravel. pH 5·2.
C_p	4-40″	Light olive (moist) loamy sand, weak subangular blocky structure breaking to single grain structure, slightly compact, porous, no stones or gravel. pH 6·1.

Horizon	*Depth*	*Description*
B_{2gw}	40 & 42	Brownish yellow (moist) sandy loam, with thin layers of clay ½" thick. The clay layers are compact and semi-impervious. Distance between clay layers varies from 1" to 4". pH 6·2.
B_{3gw}	42-60"	Light olive (moist) sandy loam, slightly blocky, breaking to crumb structure, slightly compact, soft and penetrated by roots, mottled with dark yellowish brown (moist) iron stains in spots and streaks, no stones or gravel. pH 6·5.
C_{gw}	60" +	Light olive (moist) loamy sand, loose calcareous crusts around dead roots, mildly calcareous, no stratification. pH 8·3.

Agriculture

The Oldtown series is well-drained and submarginal for agriculture without irrigation. In the natural state it is suitable only for forest and forest-range. If irrigated and fertilized this soil type would produce any crop that may be grown in the prevailing climate.

In new land the primary deficiencies are organic matter, nitrogen, phosphorus and potash. Application of these materials would give the first crop a start, after which legumes and other sod crops help to build up the soil for a more varied agriculture. One area of the type is irrigated. This is on part of a bench near the mouth of Perry Creek. The irrigated acreage is productive for legumes, hay and vegetables.

The clearing of forest can be accomplished by machinery, the stand of trees being open and the growth medium to small with scattered mature trees. No stone removal is necessary.

Irrigation water cannot be run in unlined ditches without excessive loss, owing to the porosity of the soil parent material, and such loss would create seepage. The farm duty of water is about 30 acre-inches. Since well water is generally unavailable, cisterns are required for storage when the irrigation system is not in use.

Under the classification of soils according to their suitability for irrigation, there are 308 acres of First Class land, 624 acres of Second Class, 460 acres of Third Class and 954 acres of Fourth Class land, all with undulating topography. There are also 63 acres of Third Class and 419 acres of Fourth Class land with duned topography. The total irrigable land in this soil type amounts to about 2,829 acres and there are about 255 acres with rough, broken topography, which was classed as non-arable land.

Flagstone Sandy Loam

The Flagstone Sandy Loam is derived from the calcareous sandy deposits that are end-products of glaciation. These are sandy channel and terrace deposits and such deposits reworked by wind. The type occurs between 2,350 and 2,700 feet elevation, and the total area amounts to about 18,686 acres.

The topography has three phases. Some areas have gentle slopes similar to the slopes of sand bars of former streams, and this category amounts to about 11,357 acres. There is a duned phase covering approximately 3,215 acres, where the original sandy deposits have been shaped into dunes by the prevailing wind. There is also some rough, broken land (4,134 acres), possibly caused by early erosion or collapse of the surface after melting of buried ice.

The parent material consists of calcareous medium to fine sands of variable thickness, sometimes containing thin layers of gravel. The strata that underlie the sand may be stratified gravel, silt or glacial till. Where the sand stratum is thin and river gravels lie beneath, the uprooting of trees has brought stones and gravel to the surface. Near the Kootenay River trench, stratified silt often underlies the sand formation and layers of silt may be found in the stratified sand. In the duned phase the sand has been deposited with uniformity and considerable thickness.

The Flagstone Sandy Loam is a forest type, classed as a Brown Wooded soil. It produces fir, larch, ponderosa pine and lodgepole pine in scattered stands. The main undercover consists of antelope bush, rose, saskatoon, waxberry, pine grass and a few other shrubs and grasses.

The soil itself is a weakly developed, light grayish brown, calcareous sandy loam to a depth of about 17 inches, seldom containing stones or gravel. The weak development is in part due to erosion of the surface and stirring of the profile by uprooting trees. Below 17 inches the material becomes light yellowish brown loamy sand.

A profile of the type was examined in an area about half way between Dorr and Edwards Lake, in the southern part of the mapped area. The forest growth was mature ponderosa pine, the trees being up to 12 inches in diameter. The undercover plants were mainly grasses and the topography is almost flat. This profile is described as follows:

Horizon	*Depth*	*Description*
A_0	½- 0″	Dark brown undecomposed and partly decomposed forest litter, chiefly needles, twigs and grass.
A_1	0- 3″	Light grayish brown (dry) sandy loam, weakly plated, breaking to granular structure. Firm, porous, no stones or gravel, many small roots. pH 7·2.
B_{3ca}	3-17″	Light gray (dry) sandy loam, blocky, compact, no stones or gravel. Free carbonate. pH 8·6.
B_{4ca}	17-36″	Light yellowish brown (dry) loamy sand, massive, limey, weakly cemented when dry, porous, no stones or gravel. pH 8·9.
C	36″ +	Gray (dry) stratified loamy sand of medium texture. May contain layers of gravel and/or silt. Underlaid at various depths by gravel, silt or glacial till. Reaction at 36″ pH 9·0.

While slight variations of texture, depth of horizons and reaction occur in different places, the above profile identifies the Flagstone series. This type of soil is distributed in small, scattered areas throughout the district. The analysis of this profile, shown in Table 6, gives an idea of the high calcium carbonate content of the lower horizons. Since the high reaction is not due to seepage alkali, it does not appear to interfere with irrigated agriculture.

Agriculture

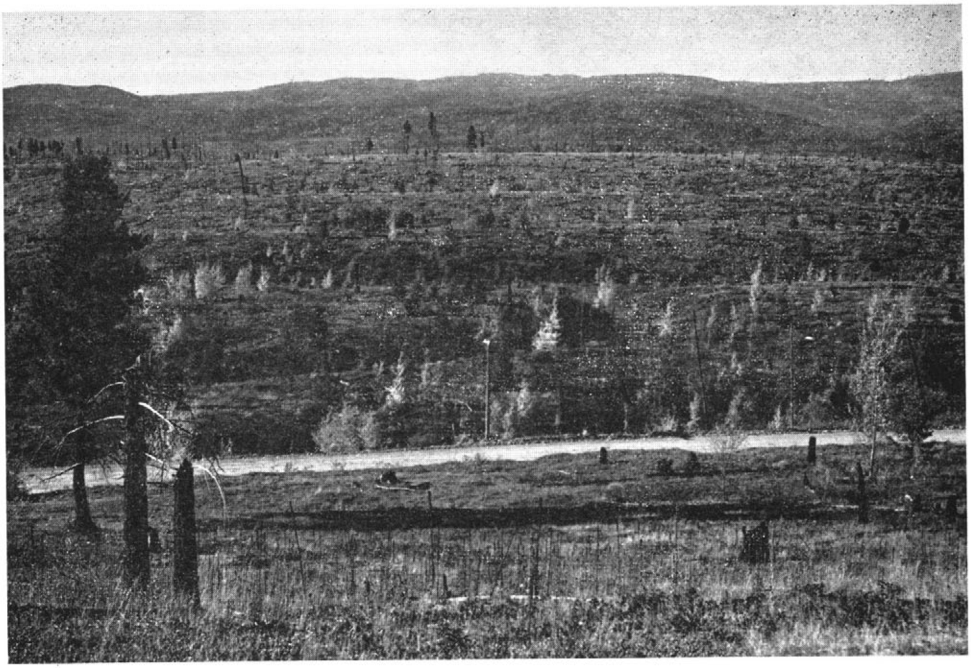
The Flagstone Sandy Loam is submarginal for agriculture without irrigation. In the dry condition it is suitable only for forest and forest-range. If irrigated the type would produce any crop not requiring an acid soil that can be grown under prevailing climatic conditions. Lime tolerant crops are indicated.

As new land ready for irrigation and cropping, the preliminary deficiencies are organic matter, nitrogen, phosphorus and possibly potash. Trace element deficiencies are likely to occur, particularly after years of farming. After preliminary fertilization to give the first crops a start, the crop growth and yields will gradually increase.


Meandering course and floodplain of the Kootenay River


Open stand of Douglas Fir and Ponderosa Pine on Wycliffe Silt Loam.

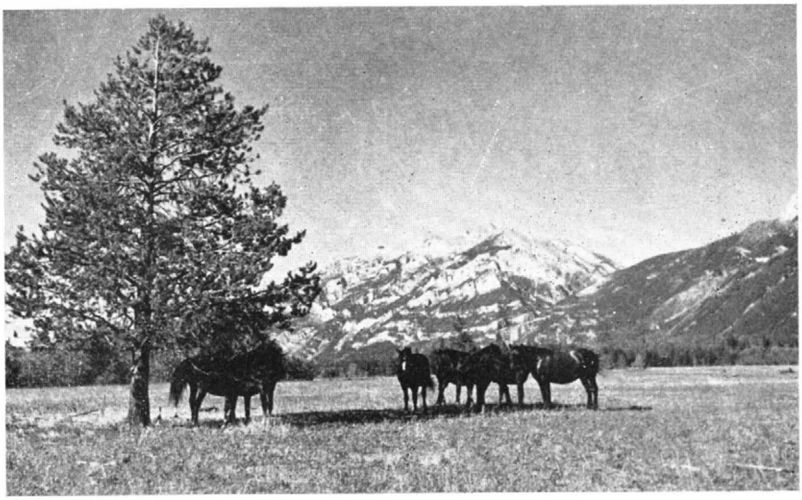

Typical flat terrace topography of Saha soils.



Rolling topography characteristic of Wycliffe Soils.

Farm on Wigwam Complex near Roosville, B.C.

Stand of Lodgepole Pine and Douglas Fir on Nestor Silt Loam.



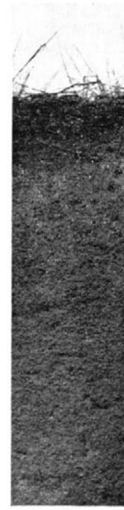
Grazing on natural grassland, Michel Sandy Loam.

Crop of irrigated alfalfa on Saha Silt Loam.


1


2


3


4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6


7


8


9

Representative Soil Profiles

Dark Brown Soils—1. Saha Silt Loam
Brown Wooded Soils—2. Wycliffe Silt Loam
3. Mayook Silt Loam
4. Flagstone Sandy Loam
5. Lakit Sandy Loam
6. Wigwam Soil Complex
Gray Wooded Soils—7. Nestor Silt Loam
8. Wigwam Soil Complex
Podzolized
Gray Wooded Soils—9. Narboe Clay Loam

Under irrigation the type of agriculture should be mixed farming. Large irrigated farms are required to pasture and winter feed the livestock, without depending on vacant land for pasture. Irrigation water should be flumed or piped to points of distribution. Open ditches in the soil itself would bring excessive loss of water from seepage. The farm duty of water is approximately 3 acre-feet.

Land clearing involves the removal of a thin forest of shallow rooted trees, old logs, partly rotted stumps and antelope bush. This is light clearing and machinery could be used to advantage. Stone removal may be necessary along soil boundaries where the Flagstone Sandy Loam is in contact with stony types of soil.

Small areas are irrigated near Newgate on the west side of the Kootenay River. These areas show that where the Flagstone Sandy Loam is cultivated, watered and fertilized, the land can be made to produce good crops of vegetables, potatoes and hay.

Under the classification of soils according to their suitability for irrigation, there are about 8,856 acres of undulating and 1,055 acres of duned Second Class land. Third Class land consists of 2,033 acres of undulating and 1,922 acres of duned topography. In the Fourth Class of irrigated land, there are 448 acres of sloping and 238 acres of duned topography.

Kayook Silt Loam

During the retreat of the glaciation, gravelly terraces were formed in the valleys of streams tributary to the Rocky Mountain Trench, and at their points of entry into the main rivers. The materials are calcareous and the age and position of these terraces is the same as the terraces from which the Elko-Saha soils are derived. The Kayook Silt Loam differs from the Elko-Saha soils by greater thickness of the silt and fine sand that overlies stratified gravels.

Areas of this type are located in the vicinity of Wasa, and near Canal Flats, where the Kootenay River enters the Rocky Mountain Trench. The total area is relatively small, with only 3,525 acres in the Kootenay River drainage basin.

The topography is gently sloping, with slightly undulating micro-relief, the latter originally being formed as stream braids. In some places there are low terraces in series with from two to six feet differences of elevation and a tendency to merge into one another. The range of elevation is from 2,650 to 3,000 feet above sea level.

The soils are well drained, the surface textures being from silt loam to very fine sandy loam. Silt loam is the most common texture. The overlay of fine material on gravel ranges from 14 to 42 inches and is generally stone free, except where stones have been heaved to the surface by uprooting trees.

The gravel substratum is often mixed with silt and several grades of sand. The gravel varies from small sizes to stones several inches in diameter, the latter being subangular to well rounded. The stones consist of quartzites, agglomerates, argillites and a high percentage of limestones. The gravel varies in depth from 10 to 50 feet or more, and may be underlaid by glacial till, stratified silt from which Mayook series is derived or older deposits.

The Kayook series is a Brown Wooded soil with semi-open tree cover. The forest consists of fir, lodgepole pine, juniper, shrubs and a thin growth of grass. In places there are park-like open areas up to an acre in extent containing scattered fir, juniper, koelaria grass and weeds.

A profile was examined about a mile south of Canal Flats bridge, near the main highway. This is the largest area on the soil map. The parent material was deposited by the Kootenay River near its exit from the Rockies, and the resulting soil and substratum are strongly calcareous. This profile is described as follows:

Horizon	*Depth*	*Description*
A_0	½- 0″	Forest litter consisting of needles, twigs, grass, etc.
A_1	0- ½″	Dark grayish brown (dry) silt loam, fluffy fine granular structure. pH 7·0.
A_2	½- 2″	Light yellowish brown (dry) silt loam, weakly platy, soft, friable. pH 7·4.
B_2	2- 6″	Pale yellow (dry) silt loam. Very weakly blocky, breaking to crumb structure, porous and friable. No stones or gravel. pH 7·4.
B_{ca}	6-21″	Pale yellow (dry) silt loam, loose granular to weakly blocky. Main area of feeding roots. Scattered concretions of lime-cemented silt up to ¼″ diameter probably formed by the action of roots, calcareous. pH 9·2.
C	21″ +	Light gray (dry) calcareous silt loam, stratified, no stones or gravel. pH 9·1.
D		Stratified river gravels at from 14″ to 4 feet below the surface.

Agriculture

In the natural condition the Kayook series is suitable for forest-range only. With irrigation it is capable of producing any crop that can be grown in the prevailing climate. The subsoil drainage is good.

The high pH in the lower part of the soil profile is a result of downward movement of carbonates from the A and B_2 horizons. Under these conditions the B_{ca} horizon will become less alkaline when irrigated. Levelling of the land is not recommended because crops will not grow on exposed B_{ca} material.

Land clearing of trees and brush is from medium to light, excepting in the Kootenay River valley upstream from Canal Flats, where the vegetation is from medium to heavy forest. Preparation of the soil for agriculture may include the application of organic matter, complete fertilizer and a supplement of ammonium sulphate or ammonium nitrate.

Under irrigation the type of agriculture should be mixed farming, the farm duty of water being approximately three acre-feet. About four irrigations are required between May and September, and a fall irrigation should be applied when necessary. Rill or furrow irrigation is unhandy in hay fields, owing to difficulty with mowing and the flood method requires ideal topography. Sprinkler irrigation, which is the most satisfactory, is used by farmers who are able to pay the cost of installation.

Under the classification of soils according to their suitability for irrigation, there are about 2,579 acres of Second Class land and 946 acres of Third Class land in the Kayook series.

Lakit Sandy Loam

This type consists of a group of gravelly and stony soils similar in profile to the Hyak series. Like the Hyak soils the Lakit series is weakly to non-calcareous, but differs as to position and greater youth. The Lakit soils occupy terraces and fans just above second bottom height where tributaries enter the channel of the Kootenay River, whereas the Hyak soils refer back to the time of deglaciation in the valley bottom. Since the Lakit series is derived from fan-like formations, it can be regarded as a differentiated member of the Wigwam Soil Complex.

The Lakit soils occur near the mouths of the St. Mary and Skookumchuck rivers, which drain from the Purcell Mountains. The range of elevation is from 2,500 to 2,750 feet, and the total area mapped amounts to about 2,478 acres.

The topography is undulating to gently sloping in the several scattered areas. While the average texture is sandy loam, areas of loam occur with included boulders. The number of stones and boulders at the surface is dependent on the thickness of the surface soil and the amount of boulders in the D horizon. This soil type is excessively drained.

The parent materials consist of sand, gravels and stones overlaid by finer material. The conditions of deposition were those of a river bottom over which the river had a fairly rapid rate of flow. Downcutting of the stream caused gradual abandonment of the gravelly areas, but during this stage the gravels were given a surface coating of silt and fine sand at the time of the annual freshets. Finally, most areas of the type became too high above the level of runoff to receive any more additions of fine sediment.

The sandy loam and loam surface soil is only from 6 to 12 inches thick on top of the coarse substratum. The gravelly and stony substratum is of variable thickness, overlying older deposits. Since the Lakit soils lie around second bottom height, there is generally a water table at variable depth. A mixture of scattered trees and grass develops where the water table is at the greatest depth, and groves of trees or continuous forest occur where the tree roots can reach moisture.

A profile was described in a grove of Douglas fir. This is located about 200 yards northeast of the St. Eugene Mission bridge across the St. Mary River. The description is as follows:

Horizon	*Depth*	*Description*
A_1	0-1½"	Very dark gray (dry) sandy loam. Weakly platy breaking to weak crumb structure; porous, friable. Scattered surface gravel, stones and boulders. pH 6·4.
A_3	1½- 6"	Light yellowish brown (dry) fine to very fine sandy loam; weakly platy, breaking to medium crumb structure, porous and friable. Scattered stones and gravel. pH 6·5.
B-D	6-12"	Grayish brown (dry) fine sands mixed with stones up to 8" diameter, and coarse and fine gravel, the sands having single grain structure. Porous and loose. pH 7·2.
D	12" +	Light brownish gray mixture of river gravels, stones, boulders and sands. Some lime plating on stones. pH 6·9.

Agriculture

The profile is thin and the range of lime content is from weakly calcareous to non-calcareous, the soil reaction being neutral. In the native state the Lakit soils have limited value as forest-range or forest. The total area of 2,478 acres was classed as non-arable land.

Kokum Very Fine Sandy Loam

The Kokum series consists of a group of sandy soils derived from weakly to non-calcareous parent materials. These soils occur on terraces and fans at second bottom height where tributaries enter the channel of the Kootenay

River. The parent materials of the Kokum and Lakit soils were laid down under comparable conditions at the same time. Since the formation is chiefly fan-like, the Kokum series can be regarded as a differentiated member of the Wigwam Soil Complex.

The type occurs near the mouth of Gold Creek, on the second bottoms of Perry Creek, near the mouths of the St. Mary and Skookumchuck rivers and Findlay Creek. The range of elevation is from 2,500 to 3,200 feet above sea level, and the mapped area amounts to about 3,409 acres. The topography is gently sloping, with indentations caused by abandoned stream channels.

The soil textures are fine sandy loam to very fine sandy loam, the latter being most common. In places stones and gravel may be brought to the surface from the substratum by uprooting trees. The type has a weakly developed solum, indicating comparative youth.

In the mapped area the material from which the Kokum soils are derived came from glaciation of rusty weathering rocks in the Purcell Mountains. In appearance this material is similar to the parent material of the Oldtown series, and the loess that forms a thin coating over most soils of the region.

The native vegetation includes ponderosa pine, cottonwood, larch, spruce, lodgepole pine and willows. The shrub layer includes snowberry, oregon grape and rose.

The Kokum soils have a water table at variable depths. While on the average the water table is high enough to support a forest, the density of growth varies within fairly wide limits. The forest grades from scanty growth to a medium and heavy volume in comparison with the well-drained soils of the region.

A profile of the type was examined on the St. Mary River flats, where the St. Mary River joins the Kootenay. This profile is described as follows:

Horizon	*Depth*	*Description*
A_0	1- 0″	Dry needles, twigs and dead grass, undecomposed.
A_2	0- 2″	Light yellowish brown (dry) very fine sandy loam, weakly platy, breaking to single grain structure, friable. pH 7·7.
B	2-12″	Pale yellow (dry) very fine sandy loam, weakly blocky breaking to crumbs and single grains. No stones or gravel. pH 8·2.
C	12″ +	Light gray (dry) very fine sandy loam, slightly iron stained, stratified, no stones or gravel. pH 8·0.
D		Stratified river gravels underlie the sand stratum at variable depth.

The weak development of the profile is in part due to uprooting trees, which mix parent material into the solum. The reaction is slightly higher than normal owing to slight contamination from limey Salishan soils nearby.

Agriculture

The soil is submarginal for agriculture without irrigation. If irrigated and fertilized it would produce any crop that can be grown under local climatic conditions.

Clearing of the land could be accomplished by machinery, the stand of trees being fairly small, and there are few mature trees remaining. No stone removal is necessary. After clearing the primary need is to build up organic matter in the soil and supply available nutrients to the first crop. This can be done by application of manure and complete fertilizer. Thereafter, legumes and other sod crops will build up the soil for a varied agriculture.

With irrigation the type of agriculture should be mixed farming. Comparatively large farms are required under the climatic conditions that prevail in the upper Kootenay River valley. While irrigation water can be run in open ditches the loss is considerable, and piping or fluming to points of distribution would be more practical. The farm duty of water for this type is approximately 30 acre-inches. In most parts of the Kokum series a domestic water supply can be obtained from shallow wells.

Under the classification of soils according to their suitability for irrigation, the Kokum series contains about 2,530 acres of Second Class land, 766 acres of Third Class and 113 acres of Fourth Class land.

Michel Sandy Loam

The Michel series is derived from calcareous surface materials on low terraces of the Elk River. The bulk of the terraces consist of gravels and sands eroded from till. Before being abandoned by the river the gravelly deposits were surfaced to variable depth by fine-textured soil-forming materials. The distinguishing feature of the Michel soils is their dark color, inherited chiefly from the soft black shales of the Kootenay formation.

Areas of Michel Sandy Loam occur just above the level of the second bottoms between Elko and Martin Creek, with a range of elevation from 3,150 to 4,100 feet. The total area mapped amounts to about 4,852 acres. The topography is gently sloping to gently undulating. Many of the terraces have a slight inward slope from the river. There is also a very slight slope in a downstream direction. While the range of surface texture is from sandy loam to clay, the bulk of the acreage is sandy loam and heavier textures are confined to small areas.

Above Sparwood in the less humid part of the Elk River valley, the Michel soils are covered by light, second-growth forest. This consists of fir, spruce, lodgepole pine, larch, juniper and aspen. The ground cover includes wild rose, kinnikinnick, snowberry, oregon grape, strawberry, lupine, vetch and pine grass. The moist region between Hosmer and Morissey once supported a heavy growth of vegetation on the Michel soil areas. The species are the same as in the less humid section with the addition of hemlock, cedar, willow and cottonwood.

The fine-textured surface soil that overlies gravel varies in thickness from less than a foot to several feet in depth in different areas, and the value of the land for agriculture varies accordingly. A profile representative of the medium depth of solum was located about three miles northeast of Hosmer near the main road. In this area there is a hummocky micro-relief and the vegetation is fir, spruce, lodgepole pine and aspen second growth of medium density.

The description is as follows:

Horizon	*Depth*	*Description*
A_0	1- 0″	Forest litter of needles, twigs, grass, etc., well decomposed in the lower part.
A_2	0- 1″	Light brownish gray (dry) loam, fluffy, weakly plated, friable. pH 6·9.
A_3	1- 5″	Pale brown (dry) sandy loam with high content of very fine sand. Granular, soft porous. pH 7·5.
B_1	5- 9″	Brown (dry) sandy loam, weakly blocky, soft and porous. No stones or gravel. pH 7·6.
B_2	9-12″	Dark brown (dry) sandy loam, weakly blocky, slightly compact. No stones or gravel. pH 7·5.
B_{ca}	12-24″	Light olive (dry) sandy loam, weakly blocky structure, no stones or gravel, calcareous. pH 7·7.
D	24″ +	Dark grayish brown (dry) dirty stratified gravels. Porous, excessively drained.

Agriculture

The climate of the Elk River valley is more humid than the climate of the Rocky Mountain Trench. The rainfall is sufficient to encourage dry farming on the heavier soils, but the yields obtained are no more than half of the production of which the soils are capable. The excessively drained soil types, such as the Michel series, are marginal without irrigation.

In the locality between Sparwood and Nordstrum Creek the Michel soils are settled and to some extent farmed. Grain, hay and pasture are produced and used for beef and dairy production. However, the land has been subdivided into comparative small parcels, the farms are too small except for part-time farming, and yields without irrigation are too low.

Under irrigation the type of agriculture should be mixed farming. Owing to the greater humidity of the Elk River valley, in comparison with the climate of the Rocky Mountain Trench, the farm duty of water is only about 18 acre-inches. Piping or fluming of irrigation water to points of distribution is necessary. Well water for domestic use should be obtainable on terraces not too far from the Elk River.

The organic-matter content of the Michel Sandy Loam is low. For increased production these soils need building up with manures, legumes in crop rotations and commercial fertilizers.

Land clearing is heavy in the moist area between Fernie and Morrisey, and lighter in the locality around Sparwood. Stone removal is essential in places where the Michel profile is thin.

Under the classification of soils according to their suitability for irrigation there are 1,450 acres of Second Class, 1,442 acres of Third Class and 1,923 acres of Fourth Class land.

3. Gray Wooded Soils

Gray Wooded soils occur upstream from Canal Flats in the Kootenay River valley. They are also found in the Elk River valley and within the limits of a few storm tracks in the Rocky Mountain Trench. On the dry side of the Gray Wooded soil region are the Brown Wooded and in turn the Dark Brown soils. On the humid side the close relative is the Podzolized Gray Wooded soil.

Wherever possible the normal Gray Wooded soils have been separated from the Podzolized Gray Wooded soils on the soil map. Where not sufficiently distinct from one another for differentiation, due to the minor nature of the podzol development, the soils were mapped together. Areas mapped as Kinbasket-Flatbow soils serve as an example. The Kinbasket series is a Gray Wooded soil type, whereas the Flatbow soils belong in the Podzolized Gray Wooded soil group.

The Gray Wooded soils are best developed in calcareous, heavy textured materials. It is apparent that such heavy textures resist profile development for the longest period of time, and they remain in the Gray Wooded stage of development while lighter textured soils nearby become Podzolized Gray Wooded or Brown Podzolic soils.

Where the more or less mature Gray Wooded soil development has taken place, the essential features of the profile are as follows:

Horizon	*Description*
A_0	Accumulated forest litter, varies from one to three inches thick according to vegetative cover.
A_2	Very pale brown to light gray, platy structure, from two to five inches thick.

Horizon	*Description*
A_3	Light yellowish brown transitional horizon from two to five inches in thickness, sometimes absent.
B_1	Brownish yellow transitional horizon, compact, blocky structure, from two to five inches thick, sometimes absent.
B_2	Yellowish brown, compact, blocky. The horizon of heaviest texture. Varies from four to eight inches in thickness.

There are well-developed A_2 and B_2 horizons, both of which are slightly acid. Horizons A_3 and B_1 are transitional, and named according to closest relationship with the one above or below. Colloidal clay and iron have moved downward to accumulate in the dense horizon B_2, beneath which there is a calcareous horizon designated B_{ca}, the reaction of which may reach pH 8·0 or higher.

Eight Gray Wooded soil types were classified and given the following names: Kinbasket Silt Loam, Hosmer Clay Loam, Cedrus Clay, Hornickel Silt Loam, Abruzzi Clay, Codorna Loam, Madias Silty Clay Loam and Nestor Silt Loam.

Kinbasket Silt Loam

The Kinbasket series is a group of stony soils derived from the strongly calcareous glacial till which is also the parent material of the Wycliffe series. In the mapped area these soils occur in the vicinity of Kimberley and in the locality around Jaffray. In both areas they were mapped in association with the Flatbow series as Kinbasket-Flatbow soils, the area of the two types being about 43,066 acres. The highest elevation occurs to the north of Cherry Creek at about 3,500 feet above sea level. The lowest elevation is approximately 2,600 feet near the mouth of Sand Creek.

The drumlinized topography varies from rounded hills with steep north and lateral slopes to rounded hills with moderate slopes in all directions. Areas with moderate stoniness and topography suitable for agriculture amount to about 18,922 acres. There are also about 21,336 acres of steep, morainic, non-arable topography and 2,808 acres of excessively stony land classed in the group of Kinbasket-Flatbow soils.

The soil textures are mainly silt loam, with occasional areas of loam. Addition of silt and very fine sand to the solum by wind action has occurred in the past. The amount of loess varies from a thin, scarcely observable mantle to a foot or more of stone-free soil.

The chief soil limitations to cultural practice consist of stoniness and topography, and areas of the type are graded accordingly. Excessive gravel and stones occur in areas where the surface of the till has been subject to weathering and removal of the fine materials, of which the bulk of the till is composed.

The vegetation varies from medium on the south slopes to heavy density on the north slopes. The most abundant cover is lodgepole pine, with scattered fir, larch and aspen. There is a shaded ground cover of snowberry, wild rose, strawberry, saskatoon, kinnikinnick, pinegrass and others.

The essential difference between the Kinbasket and Flatbow soils lies in the condition of horizon A_2 of the soil profiles. The Kinbasket soils have a moderately thin Gray Wooded A_2 horizon, whereas the Flatbow soils have leached more deeply and the Gray Wooded horizon A_2 is podzolized.

A profile representative of the Kinbasket soils around Kimberley and Jaffray is described as follows:

Horizon	*Depth*	*Description*
A_0	2- 0″	Forest litter, needles, grass, etc., well decomposed in the lower part.
A_2	0- 4″	Light yellowish brown (dry), yellowish brown (moist) loam, platy, porous, friable, scattered grit and gravel. Some surface stones and boulders. pH 5·7.
B_1	4- 9″	Yellowish brown (dry & moist) silt loam, blocky, breaking to crumb structure, firm. Scattered grit, stones and boulders. pH 6·7.
B_2	9-17″	Yellowish brown (dry & moist) clay loam, blocky, breaking to crumb structure, fairly compact, porous in fractures. pH 7·1.
B_{ca}	17-30″	Very pale brown (dry), brown (moist) loam to silt loam, subangular blocky structure, fairly compact; gritty, gravelly, scattered stones and boulders. Root mat in the lower part. pH 8·0.
C	30″ +	White (dry), very pale brown (moist), loam to silt loam textured compact till, containing variable amounts of stones and gravel. Very calcareous in the zone of contact with the solum. pH 8·6.

Agriculture

The present use of the Kinbasket soils is for forest and forest-range. After the virgin timber has been taken off, the land is cropped for Christmas trees. Where the topography is favorable and surface stone is not excessive, the Kinbasket soils are suitable for irrigation. Under irrigation the type of agriculture should be mixed farming. The farm duty of water is about 28 acre-inches for the irrigation season.

Before irrigation and cultivation the clearing of forest and removal of stones and boulders are necessary. In most of the area the forest is of medium density. The original timber has been logged, and much of the area is burned over. The stones may require periodic removal until the solum has been cleared.

When the land is cleared and prepared for farming, the addition of organic matter and commercial fertilizers is necessary to start the first crop. Soil fertility and crop production will increase when deficiencies have been satisfied and the best crop varieties for the district are used. Sprinkler irrigation is recommended, with light applications of water as required. Excessive applications of water will cause saturation of the solum and downslope seepage, owing to the impervious substratum. Care should be taken to avoid erosion in this soil type.

The possibility of finding well water is very limited, owing to the well-drained topography and the impervious nature and thickness of the till. Cisterns will be necessary for the storage of domestic water and water for stock when the irrigation system is not in use. Where the till is thick and compact, the water loss is low and cisterns with no linings may be possible.

Under the classification of soils according to their suitability for irrigation, the Kinbasket-Flatbow soil group contains about 3,890 acres of Second Class and 15,052 acres of Third Class land.

Hosmer Clay Loam

This type occurs in the Elk River valley to the north of Natal, the largest area being on the east side of the valley between Emerald Lake and the Fording River. The elevations at which it is found lie between 3,800 and 4,300 feet above sea level.

The topography is undulating to rolling, with a general slope towards the valley center, and there is a small area of rough, broken land. The total area of the type amounts to about 6,515 acres, of which 6,312 acres are potentially arable if irrigated, and 203 acres are in the rough, non-arable topography.

The Hosmer Clay Loam is derived from glacial till, which differs from other tills in the mapped area. The material from which the Hosmer till was formed consists largely of soft yellowish-brown to black shales of the Fernie and Kootenay formations. There is also an inclusion of limestone in sufficient quantity to make the till calcareous. It contains varying amounts of stones, gravel, scattered black shale and coal. The till is compact and impervious to water.

Since the climate is summer-dry, the mature vegetation was a mixed forest of fir, larch and spruce. The original growth was destroyed by fire and replaced by medium to heavy aspen, willow and lodgepole pine. The shrubs are wild rose, snowberry, saskatoon and others. The ground cover is mostly pine grass containing strawberry, fireweed, aster and many small plants. The growth is heavy in the depressions and light on the knolls, where there is less moisture.

With the exception of depressions the type is well drained. The soil texture varies from loam to clay, the average being clay loam. Stone content varies from stony to comparatively stone-free areas, but stone is not sufficiently plentiful anywhere to render the land non-arable.

A soil profile, located on the soil map, was examined about 8 miles north of Sparwood, on the east side of the valley. The elevation at this point is 4,220 feet. The description is as follows:

Horizon	*Depth*	*Description*
A_0	1- 0″	Very dark grayish brown forest litter, raw and thin.
A_2	0- 3″	Pale brown (dry), yellowish brown (moist) silt loam, weakly platy, breaking to granular structure, friable, porous, scattered gravel. pH 6·1.
B_1	3- 7″	Pale brown (dry), yellowish brown (moist) clay loam, small blocky structure, porous in the fractures, scattered gravel and stones, compact. pH 6·8.
B_2	7-11″	Light yellowish brown (dry), dark yellowish brown (moist) blocky clay, porous in the fractures, compact, scattered stones and boulders. pH 6·9.
B_{ca}	11-19″	Grayish brown (moist) clay, blocky, breaking to smaller sizes of the same shape, compact, contains bits of till, scattered stones and gravel; root mat in the lower part, calcareous. pH 7·7.
C	19″ +	Grayish brown (moist) loam textured compact till with angular fracture, more stones and boulders than in the soil above. Impervious, calcareous. pH 7·8.

It is worthy of note that the colors of the several soil horizons of this soil type are in part controlled by the dark color of the parent material. The till is from dark brown to grayish brown, and it weathers to several shades of yellowish brown.

Agriculture

While very little of the Hosmer series is farmed, the land is all held in private ownership. A difficulty with farm development is the high cost of clearing. In the farmed area north of Wilson Creek fair crops of grain and pasture were observed. However, the climate is summer-dry, and while irrigation is not so necessary as in some parts of the mapped area, the yield obtainable could be doubled by irrigation and better farm practice. The land is most suitable for legumes, hay, grain, hardy roots and vegetables.

The farm duty of water is one acre-foot for this soil. Aside from a few springs near the mountain boundary, there is little possibility of a farm water supply from wells. Where spring water is not available a supply can be stored in unlined cisterns when the irrigation system is not in use.

After the tree cover has been removed, the rolling topography requires that conservation measures should be taken to prevent soil erosion. Stones are scattered, except on knolls where they are more abundant.

Aside from moisture, the observable soil deficiency is organic matter, a common lack in Gray Wooded soils. The use of manures and rotations are the best ways of improving the soil for agriculture. On clearing new land, manure or sawdust and nitrogen and a complete fertilizer is advisable, to give the first crop a start.

Soil drainage is good under the dry conditions. Under irrigation the sprinkler system is advisable to prevent erosion and saturation in a soil type that has an impervious substratum. Excessive use of irrigation water would cause seepage at the toe of the slope.

Under the classification of soils according to their suitability for irrigation, there are 4,308 acres of Third Class and 2,004 acres of Fourth Class land.

Cedrus Clay

The Cedrus Clay occurs in the Kootenay River valley above Canal Flats. There is one isolated area several miles upstream from Canal Flats on the south side of the valley, and the remainder of the mapped acreage lies to the north of Gibraltar Rock.

The elevation of this type ranges between 3,150 and 3,800 feet above sea level, and the total acreage mapped amounts to about 14,056 acres. The topography consists of a rough, broken phase covering 841 acres, a rolling morainic phase with an area of 902 acres and an undulating to gently rolling phase that occupies about 12,313 acres. The potentially arable area is confined to the undulating and gently rolling topography.

A feature of note is the nature of the parent material, most easily described in the broad valley above Gibraltar Rock. In this area the valley was excavated in a vast deposit of the McKay Groups. In the mapped area this consists of calcareous phyllite, white and hard when dry, and light gray, soft and plastic when wet. Valley glaciation of the McKay Groups produced calcareous clay-till containing moderate amounts of stones and gravel. Clay-till moraines were deposited in contact with the McKay bedrock, hence the valley ice in this area did not transport material for any considerable distance. The Cedrus Clay is derived from the calcareous clay-till.

The native vegetation is chiefly second growth of medium density. It consists of lodgepole pine and a few fir, spruce, larch and aspen, the few mature trees being a foot or more in diameter. Most of the area was logged in the 1930s, and some of it was burned over. The ground cover consists of a few shrubs, herbs and pinegrass.

The soil texture is mainly clay, but in small areas loam and silt loam occur. There are scattered stones and gravel, except on eroded knolls, where the stones are more concentrated. The whole series is moderately well drained.

A representative profile, located on the soil map, was examined about half a mile south of Fenwick Creek on the east side of the Kootenay River. In this locality the topography is undulating to rolling. The pit was dug on a low knoll at 3,420 feet elevation, and it is evident that the soil texture in the nearby hollows is somewhat lighter than on the knolls and slopes. The vegetation consisted of scattered lodgepole pine, larch and fir; an open forest that had been logged. The profile is described as follows:

Horizon	*Depth*	*Description*
A_0	1- 0″	Dark brown forest litter. Raw on top and well decomposed in the lower part.
A_2	0- 2″	Light gray (dry) clay loam, platy structure breaking to angular crumbs, porous. Scattered grit and small gravel. pH 6·1.
A_3	2- 4″	Pale yellow (dry) clay, weakly platy breaking to blocky structure. Scattered small gravel and stones. Compact, porous along fractures. pH 5·9.
B_2	4- 9″	Light olive gray (moist) clay with heavier texture than horizon above, blocky, breaking to small structure of the same shape. Scattered small gravel and stones. The finest textured most compact horizon. Porous along fractures. pH 6·0.
B_{ca}	9-16″	White (dry & moist) clay. Granular around roots in a mass of parent material fragments; scattered stones and gravel. Slightly compact, fairly porous and calcareous; root mats in the lower part. pH 7·8.
C	16″ +	White (dry), light gray (moist) clay-till derived from phyllite. It carries the characters of the phyllite in color and cleavage. The phyllite lies in horizontal fragments meshed together. Scattered stones and gravel; hard when dry and soft when wet; compact, impervious, calcareous. Roots penetrate fractures in the upper part. pH 8·4.

Agriculture

There is no farm development on the Cedrus Clay. However, it produces better than average native vegetation, and the natural spread of alsike clover and timothy indicate an easy conversion to the production of these crops. The foliage is luxuriant where the soil is dampened by the seepage of springs.

In the prevailing summer-dry climate it is doubtful if more than half of the yield of which the soil is capable can be obtained by farming without irrigation. With irrigation the Cedrus Clay may be regarded as potentially arable for the production of hardy farm crops, the farm duty of water being about 16 acre-inches. The crops that may be grown are hay, legumes, grain and hardy vegetables. While the land is new, it can be used for specialized production of clover and grass seeds.

A deficiency of organic matter may gradually be overcome by the use of barnyard manure, green manures, sod crops and commercial fertilizers. Sawdust could be used as a source of organic matter if combined with suitable amounts of ammonium nitrate or ammonium sulphate fertilizers.

Irrigation of this soil type should be in the form of light and frequent applications, keeping in mind that the impervious till substratum will refuse to take water. Saturation of the A and B horizons will cause downslope drainage on top of the till, and create seepage areas in the hollows. Sprinkler irrigation is the ideal way of watering, throwing the cold mountain water into the air to increase its temperature. There are a few springs, but little chance of a domestic water supply from wells. On most farm units, cisterns would be required when the irrigation system is not in use. The clay-till would hold water without concrete lining of dugouts.

In the locality between Gibraltar Rock and the National Park boundary, future irrigation of this and other soil types is made possible by an abundance of water in streams cascading into the Kootenay River. At present this area is not easily accessible, owing to poor roads, but a road connecting with the National Park highway is feasible.

It is worthy of note that the abundant deer, elk and moose in the area occupied by Cedrus Clay consume large quantities of the Bca horizon material where there is downslope seepage. Calcareous animal droppings are scattered everywhere. These animals are said to be the largest and healthiest of their kind in the southern Rockies. In view of the apparent effect on game, it is thought that the lick material may have value as a mineral ration in humid parts of the Province, where the soils have an acid reaction.

Under the classification of soils according to their suitability for irrigation, the Cedrus Clay contains 11,614 acres of Third Class land and 699 acres of Fourth Class land.

Hornickel Silt Loam

The Hornickel Silt Loam is derived from sediment that filled ponded depressions during the retreat of the glacier in the Elk River valley. The sediments were eroded from the Fernie and Kootenay shales and from local limestones. The parent material is gray and calcareous, and it lies thinly on other deposits.

This type is of limited occurrence on the west side of the Elk River in the vicinity of Martin and Brule creeks. The highest elevation is about 4,300 feet near Martin Creek, and the lowest area is just south of Brule Creek at 4,150 feet above the sea. The total area mapped amounts to 540 acres.

The topography is gently undulating, with general slopes southward and towards the valley center. The soil is stone free and the texture varies from sandy loam to clay loam, the average texture being silt loam. The type has variable drainage.

The vegetation consists mainly of a thick stand of lodgepole pine, with minor inclusion of aspen and willow. The well-shaded ground cover consists chiefly of wild rose, snowberry, vetch and pine grass.

A soil profile was examined at 4,280 feet elevation about a mile north of Brule Creek and a half mile west of the power line. A description of this profile is as follows:

Horizon	*Depth*	*Description*
A_0	2- 0″	Forest litter, needles, twigs, grass, etc., well decomposed in the lower part.
A_2	0- 2″	Pale brown (moist) finely plated silt loam. pH 6·0.
A_3	2- 4″	Pale brown (moist) silt loam, weakly platy breaking to crumb structure, firm, porous. pH 6·8.
B_1	4- 7″	Yellowish brown (moist) clay loam, blocky, breaking to crumb structure, compact. pH 6·6.
B_2	7-13″	Dark yellowish brown (moist) heavy clay. Blocky, breaking to crumb structure, compact. pH 6·6.
D_{1ca}	13-27″	Light olive to gray (moist) loam, weakly stratified. This varies to silt loam and fine, calcareous sand. Soft and porous, penetrated by roots. pH 7·7.
D_2	27″ +	Light olive (moist) stony clay-till the upper part of which is strongly calcareous. Some iron staining at the point of contact with D_{1ca}. Occasionally the D_1 horizon is of considerable thickness and horizon D_2 has no significance to the soil above.

Agriculture

The Hornickel Silt Loam is not farmed at the present time and it occurs in areas of shapes and sizes unlikely to support complete farm units. However, this soil type can be included in parts of farms whose main acreage is on other soil types.

The climate is summer-dry and while some dry farming is practised in the general vicinity, irrigation is required for maximum production. The texture profile consists of a comparatively thin layer of silt loam overlying sands and till, the latter being at various depths. The nature of this profile is such that drainage problems will apear when the land is irrigated, but seepage can be handled as it occurs and this probability need not stand in the way of agricultural development. The farm duty of water is about one acre-foot. There is little possibility of a farm water supply from wells. Where spring water is not available, it will be necessary to have cisterns for the domestic supply when the irrigation system is not in use. The cisterns need not be lined provided they are established in glacial till.

Excepting moisture deficiency, the main soil requirement, after the medium forest has been removed, is organic matter and a complete fertilizer treatment. Substantial fertilization is necessary to start the first crop. When sod crops are established the soil will gain in fertility and yield.

Under the classification of soils according to their suitability for irrigation the total of 540 acres is graded as Third Class land.

Abruzzi Clay

The Abruzzi series is derived from glacio-lacustrine clays that eroded from shales of the Fernie and Kootenay formations, and from local limestones. It occurs in the Elk River valley between Sparwood and Brule Creek at elevations between 4,000 and 4,200 feet above sea level. It also occurs between Fernie and Morrissey at elevations that range from 3,250 to 3,350 feet. Areas of the type extend from the mountain boundaries of the valley to the Elk River, well above the level of present runoff. The total area mapped amounts to about 5,584 acres.

The topography is inherited from the glacial till that lies beneath the lacustrine clays. In most places the clay deposit is thin and the surface varies from gently undulating to rolling, with a general slope towards the valley center. Gullies have formed in parts of the area.

The texture is chiefly light to heavy clay, which varies to a few small areas of clay loam. The type is well drained and stone free. The parent material is pale olive to pale yellow, calcareous, stratified and varved.

In the Sparwood-Brule Creek area the forest is of medium density. It consists of lodgepole pine, spruce, aspen and willow, the low cover being snowberry, rose, blueberry and pine grass. In the more humid section between Fernie and Morrissey, the present growth consists of a thick stand of spruce, cedar, alder, birch and maple. The shrub layer is mainly salmonberry, rose and oregon grape and the ground cover consists chiefly of mosses and lichens.

A profile was examined on the west side of the valley about a mile south of Brule Creek at 4,170 feet elevation. The description is as follows:

Horizon	*Depth*	*Description*
A_0	2- 0″	Forest litter. The upper part consists of undecomposed leaves, needles, twigs, etc. The lower part is dark brown and well decomposed.

Horizon	Depth	Description
A_2	0-2½"	Pale brown (moist) silty clay loam, weakly platy, breaking to medium-sized crumbs which are held together by roots; porous. pH 5·0.
B_1	2½-4½"	Light yellowish brown (moist) clay; small nuciform structure breaking to crumbs; slightly compact. pH 5·5.
B_{21}	4½- 9"	Brownish yellow (moist) clay, blocky, compact, porous in the fractures. pH 6·0.
B_{22}	9-11"	Yellowish brown (moist) clay, smaller blocky structure than horizon above, compact, porous in the fractures. pH 6·0.
B_{ca}	11-19"	Pale yellow (moist) clay; weathered and shattered stratification, compact. pH 7·9.
C	19" +	Pale olive to pale yellow (moist) clay, stratified, varved in places. No stones or gravel. Thickness varies from a few feet to 20 feet or more overlying glacial till. pH 7·9.

Agriculture

The deep, stone free soil and favorable topography serve to make the type potentially good farmland, but land clearing is expensive, particularly in the area between Fernie and Morrissey. Parts of the Abruzzi soils are being farmed for hay, grain and pasture, but yields are low in comparison with the capability of such soils under irrigation. The low yields are due chiefly to moisture deficiency during the dry summer, and farming will continue to be limited until irrigation works are established.

Under irrigation the type of agriculture should be mixed farming. The farm duty of water is about one acre-foot for the irrigation season. Aside from a few springs near the mountain boundary, there is little possibility of a farm water supply from wells. Where spring water is not available, a supply can be stored in unlined cisterns when the irrigation system is not in use.

In addition to moisture, the observable soil deficiency is organic matter. The use of manures and rotations are the best ways of improving the soil for agriculture. On clearing the land, manure or sawdust and nitrogen, and a complete fertilizer would give the first crop a good start.

Under the classification of soils according to their suitability for irrigation, there are 5,320 acres of Third Class land and 218 acres of Fourth Class land in a total of 5,538 acres potentially irrigable.

Cadorna Loam

As the glaciers retreated the large volume of melt-water eroded glacial till, carried the fine materials downstream and left large quantities of gravel in the beds of streams. Subsequent down-cutting created terraces from the gravelly deposits, and these were surfaced with a layer of fine sands and silts by the freshets before they were abandoned. In the Elk River valley, the terraces are surfaced with dark colored fine materials of variable thickness. Those having Gray Wooded soil development were classed as the Cadorna series.

Areas of Cadorna Loam are scattered well above flood level along the Elk River from the vicinity of Morrissey to Wilson Creek, at elevations between 3,200 and 4,250 feet above sea level. In this locality a total of about 1,011 acres were mapped.

Most of the terraces have a gentle inward slope, which identifies them as remnants of former floodplains. In places the surface is gently undulating, as a result of braiding by the stream. There is also a gentle downstream slope.

The soils are well drained. Loam is the most common surface texture, but the type contains small areas of silt loam and clay loam, which were not differentiated. Aside from gravel bars, amounting to about 198 acres, the overlay of fine material on gravel ranges from about 16 to 48 inches in depth. The surface soil is generally stone-free, except where stones and gravel have been brought to the surface by uprooting trees.

The Cadorna series has a fairly open stand of secondary vegetation. The original forest of fir, spruce, and larch has been destroyed by logging and fire, and the replacement consists of a medium to heavy growth of lodgepole pine, containing fir, spruce, larch, aspen, cottonwood and willow. The shrub layer is composed chiefly of rose, snowberry and kinnikinnick, and the ground layer is mostly pinegrass and various weeds. The heavier vegetation is in the more humid region between Sparwood and Morrissey, the growth being moderate to the north of Sparwood.

A profile was examined about one quarter mile north of Sparwood in a heavy stand of lodgepole pine at about 3,640 feet elevation. This is described as follows:

Horizon	*Depth*	*Description*
A_0	2- 0″	Forest litter; needles, twigs, grass, etc., well decomposed in the lower part.
A_2	0- 4″	Dark yellowish brown (moist) loam; weakly platy, breaking to granular structure, friable, porous. pH 5·4.
A_3	4- 9″	Pale brown (moist) sandy loam, granular, friable. pH 5·5.
B_1	9-14″	Brown (dry), dark grayish brown (moist) loam, small blocky structure, compact, porous in the fractures. pH 6·5.
B_2	14-18″	Dark brown (dry), very dark brown (moist) clay loam, blocky, compact, porous in the fractures. pH 6·7.
B_{ca}	18-28″	Grayish brown (moist) loam, sub-angular blocky, breaking to granular structure, firm, porous, calcareous. pH 8·0.
D	28″ +	Dark grayish brown (moist) mixture of fine and coarse stratified river gravels and sands, lime plated stones in the upper part, calcareous. pH 8·2.

Agriculture

In the natural condition the Cadorna Loam is suitable for forest and limited forest-range. At the present time this type is dry farmed in the larger areas between Fernie and Sparwood. Farm development is restricted by the cost of clearing land. Fair crops of grain, hay and pasture are obtained and used as food for beef and dairy cattle.

The climate is summer-dry and at present the land is producing about half of its true potential. Irrigation, good management and larger farms are all necessary for a prosperous agriculture. The farm duty of water is approximately 16 acre-inches. The water should be piped or flumed to points of delivery, owing to the porous substratum. There are good possibilities of a domestic water supply from wells dug to the level of the river bottom.

The organic-matter content of these soils is low and general fertility needs building up by means of barnyard manure, green manures, legume crop rotations, sawdust combined with nitrogen and complete fertilizers.

All the Cadorna Loam soil areas can be farmed, but these areas must be regarded as supplemental to farm units that include other soil types. This type is valuable because of good topography and location.

Under the classification of soils according to their suitability for irrigation there are about 644 acres of Second Class, 169 acres of Third Class and 198 acres of Fourth Class land.

MADIAS SILTY CLAY LOAM

The Madias soils are erosion products of the clay-till from which the Cedrus series is derived. They developed on calcareous alluvial fans eroded from the Cedrus clay-till by temporary streams. These fans have spread their aprons over clay-till, gravelly terraces and other deposits to variable depth. In places where the fan material is only a few feet deep, the underlying deposits can influence the soil above. Since the Madias series is derived from fan-like formations, it may be regarded as a differentiated member of the Wigwam Soil Complex.

The Madias soils occur in the Kootenay River valley between Gibraltar Rock and the boundary of the Kootenay National Park, and there is a small area in a side valley about 5 miles upstream from Canal Flats, on the east side of the Kootenay River. The area of highest elevation is around 3,900 feet, near the southeast corner of the National Park. The lowest area, near Canal Flats, is approximately 3,200 feet above sea level. The total area mapped amounts to about 4,598 acres.

The topography is that of a fan apron, with a main downward slope and lateral slopes to right and left, all of which are comparatively gentle. The fans are not large and the general slope is invariably towards the valley center. While the average texture at the surface in the mapped area is silty clay loam, sorting of the slightly variable materials changes the texture to loam and clay loam in small areas. Stones are almost absent, owing to lack of stones in the Cedrus clay-till. The type is well-drained.

The native vegetation varies from light to heavy cover. The trees are mixed fir, small spruce, larch, lodgepole pine and aspen. In places the lodgepole pine forms a dense stand of small trees. The aspen occurs in several burned areas. Many of the tree stands are quite open, with trees about 10 feet apart. Stumps up to about two feet in diameter indicate that the original forest was logged and the present trees are second growth. The ground cover consists of vetch, rose, strawberry, kinnikinnick and pine grass. Alsike clover and timothy are common along old logging roads.

The soil profile was examined in a virgin area at about 3,590 feet elevation. This is on the west side of the valley a mile and a half north of Pedley Creek. The description is as follows:

Horizon	*Depth*	*Description*
A_0	1- 0″	Forest litter and grass, black and well decomposed in the lower part.
A_2	0- 5″	Very pale brown (dry), light yellowish brown (moist) silty clay loam, platy breaking to granular structure, porous. pH 6·2.
B_2	5- 9″	Light yellowish brown (dry), brown (moist) silty clay, sub-angular blocky structure, breaking to smaller sizes, compact, irregular in thickness and depth; no stones or gravel. pH 6·2.
B_{ca}	9-19″	White (dry), very pale brown (moist) silt loam, granular, porous, calcareous, root mat in the lower part. No stones or gravel. pH 8·1.
C	19″ +	White (dry), very pale brown (moist) silt loam, massive, contains bits of clay-till, compact, no stones or gravel, calcareous. pH 8·6.
D		An understratum at various depths. This may consist of clay-till or river terrace gravel.

Agriculture

The profile is fairly young, the topography is satisfactory, and the soil is fine textured and stone free. The calcareous nature of the parent material is an advantage for most crops. In the native state the Madias soils are suitable for forest and forest-range, but they are marginal for dry farming. There is no agriculture at present on this soil type.

With irrigation the type of agriculture should be mixed farming, with specialized crops on small acreages when such production is profitable. When irrigated the farm duty of water would be approximately 18 acre-inches. Some of the areas of Madias soils are too small for individual farm units, and where this occurs, a farm could include another soil type.

When reclaimed the forest soil requires the addition of organic matter to maintain the soil structure, and commercial fertilizers to provide available plant food for the first crops. Sawdust is often available, and when used with nitrogenous fertilizer the sawdust is a good substitute for manure.

The best place to look for a farm water supply is in the neck of the fan, where there is a substratum of clay-till. Other parts of each fan lie on till, and where there is a good drainage slope, water may be found by digging through the fan material to the till. Such water is hard and limey. There is little possibility of well water where the fan overlies a gravelly river terrace. In such areas cisterns will be required for domestic water when the irrigation system is not in use.

Under the classification of soils according to their suitability for irrigation, there are about 2,160 acres of Second Class land, 1,335 acres of Third Class land and 606 acres of Fourth Class land. Only 47 acres are rough, broken and unsuited for agriculture.

Nestor Silt Loam

The fine materials from which the Nestor soils are derived came from weathering of the McKay Groups. The resulting silts and clays, together with stones and gravel from other sources, were eroded by small streams to form alluvial fans. The fans overlie the Cedrus till and gravelly terraces. Since this type developed on alluvial fans, it may be regarded as a differentiated member of the Wigwam Soil Complex.

The Nestor fans occur in the Kootenay River valley between Gibraltar Rock and the boundary of the Kootenay National Park. They are well drained and above the present level of runoff. The highest area, near the southeast corner of the Kootenay National Park, is about 3,900 feet above sea level. The lowest area is near the junction of the White and Kootenay rivers at approximately 3,425 feet above the sea. The total area mapped amounts to about 2,697 acres.

The topography is that of a fan apron with a main downward slope and lateral slopes to right and left, all of which are gentle. The fans are not large and the general slope is towards the valley center.

The texture of the Nestor soils varies from loam to silt loam, the average being silt loam. Stones are abundant, particularly near the apex of the fan. Stoniness is the chief limiting factor in regard to the suitability of the Nestor soils for agriculture.

The native vegetation varies from medium to heavy cover, the heavier growth being near seepage from a stream or spring. Most of the areas of Nestor soils are dominated by a secondary growth of lodgepole pine, but fir, larch, spruce, aspen and birch are present in small quantities. The ground cover consists of kinnikinnick, snowberry, saskatoon, rose, vetch and pine grass.

A soil profile was examined near Fenwick Creek, and the description is as follows:

Horizon	*Depth*	*Description*
A_0	1- 0″	Brown forest litter of twigs, needles, leaves and grass, well decomposed in the lower part.
A_2	0-1½″	Light gray (dry), light olive (moist) loam, platy breaking to granular structure, firm but porous, scattered angular stones. pH 6·7.
B_{21}	1½- 6″	Light yellowish brown (dry), light olive (moist) loam to silt loam, subangular blocky structure, firm but porous, fairly compact in the upper part, scattered angular stones. pH 6·1.
B_{22}	6-11″	Light yellowish brown (dry), light olive (moist) clay loam, weak subangular blocky structure, scattered angular stones, penetrated by roots. pH 7·0.
B_{ca}	11-25″	Light gray (dry), light olive gray (moist) silt loam, granular, abundant gravel and stones up to 6″ diameter, penetrated by roots. pH 7·8.
C	25″ +	Light gray (dry), olive (moist) silt loam, a compact mixture of silt loam, gravel and stones. pH 8·0.

Agriculture

In the natural state the Nestor soils are suitable as forest and forest-range, but they are marginal for dry farming. While the topography is gentle and the soil fine textured, considerable stone clearing is required. There is no agriculture at present on this soil type.

With irrigation the type of agriculture should be mixed farming, with crops more or less limited to hay and pasture, owing to the stones in the profile. The farm duty of water is about 18 inches. A farm water supply is available in areas having small streams flowing through them. Where such streams do not occur cisterns will be required when the irrigation system is not in use. When reclaimed the soil requires the addition of organic manures and complete commercial fertilizer to start the first crop.

Under the classification of soils according to their suitability for irrigation, there are approximately 1,293 acres of Third Class, 886 acres of Fourth Class and 441 acres of Fifth Class land. These classes are graded according to their stone content. An additional 77 acres are excessively stony and non-arable.

4. Podzolized Gray Wooded Soils

The Podzolized Gray Wooded soils occur in association with the Gray Wooded soil types. In the mapped area they are located upstream from Canal Flats in the Kootenay River valley, in the Elk River valley and around Kimberley and Jaffray in the Rocky Mountain Trench.

The occurrence of Gray Wooded and Podzolized Gray Wooded soils side by side is due to a difference in the amount of weathering that takes place near the surface. In mountain valleys the amount of rainfall can vary 50 per cent or more in a short distance. In such cases Gray Wooded and Podzolized Gray Wooded soils are found closely associated on the same parent material, and the secondary podzol development is an indication of the more humid conditions.

Another observed case of the two stages of soil development in the same area is where calcareous clay and sandy or gravelly profiles receive equal precipitation. The clay is at the Gray Wooded stage and slow to change, whereas the coarser textured profiles are more effectively leached and the podzol development can be seen.

Horizons and sub-horizons of the Podzolized Gray Wooded profile are distinguished by the subscript "p" as in A_{2p}, B_p and C_p, and any remaining Gray Wooded soil horizons in the profile are similarly referred to by the subscript "gw", the common characters of the Podzolized Gray Wooded profile being as follows:

Horizon	*Description*
A_0	Dark brown accumulation of forest litter from ½ inch to two inches thick.
A_{2p}	White to light grayish brown with platy structure, from ½ inch to two inches thick.
B_p	Pale brown to brown, slightly compact, medium subangular blocky structure from one to four inches thick.
C_p	Very pale brown to yellowish brown, weak subangular blocky structure from three to ten inches thick.
B_{2gw}	Yellowish brown, blocky, compact, heavy textured, from one to four inches thick.

As noted above, the podzol development takes the form of a secondary profile within the A_2 horizon of the Gray Wooded soil profile. The new profile is sometimes only a few inches thick. It is distinguished by a thin "ashy", whitish A_{2p} horizon much lighter in color and more acid than the A_{2gw} horizon in which it develops. The B_p horizon of the podzol is brown to yellowish brown, slightly compact, with subangular blocky structure which breaks easily. This is underlaid by a pale brown horizon regarded as horizon C of the podzol profile and also the former A_2 horizon of the Gray Wooded soil.

Below the C_p horizon the Gray Wooded soil profile may exist in from a comparatively unaltered state to various stages of decomposition. Where disintegration is taking place the B_2 horizon of the Gray Wooded soil shows a loss of textural and structural characteristics, and loss of alkali earths occurs in horizon B_{ca}.

Four series of Podzolized Gray Wooded soils were differentiated in the mapped area. These are Flatbow Silt Loam, Narboe Clay Loam, Sparwood Sandy Loam and Crahan Sandy Loam.

Flatbow Silt Loam

The Flatbow series consists of a group of stony soils derived from calcareous till. The Plumbob, Wycliffe, Kinbasket and Flatbow soils all developed from the same parent material. In the mapped area the Flatbow soils occur in the vicinity of Kimberley and in the locality around Jaffray. In both areas they are mapped in association with the Kinbasket series as Kinbasket-Flatbow soils, the area of the two types being about 43,066 acres. The highest elevation occurs to the north of Cherry Creek at about 3,500 feet above sea level. The lowest elevation is about 2,600 feet near the mouth of Sand Creek.

The topography is drumlinized and variable from rounded hills with steep north and lateral slopes to rounded hills with moderate slopes in all directions. Areas of moraines occur and some of these are strongly rolling. Areas of Kinbasket-Flatbow soils with moderate stoniness and topography suitable for agriculture amount to about 18,922 acres. In addition, there are about 21,336 acres of steep, morainic, non-arable topography and 2,808 acres of excessively stony land; all classed in the group of Kinbasket-Flatbow soils.

The soil textures are chiefly silt loam, with occasional areas of loam. Addition of silt and very fine sand to the solum by wind action has occurred in the past. The amount of loess varies from a thin, scarcely seen mantle to a foot or more of stone-free soil. The type is well drained.

The main soil limitations to cultural practice are stoniness and topography, and areas of the two soil types are graded accordingly. Excessive gravel and stones occur where the surface of the till has been subject to weathering and removal of the fine materials of which the bulk of the till is composed.

The vegetation varies from medium density on the south slopes to heavy density on north slopes. The most abundant cover is lodgepole pine, scattered fir, larch and aspen. There is a shaded ground cover of snowberry, rose, saskatoon, kinnikinnick, pine grass and others.

The essential difference between the Kinbasket and Flatbow soils lies in profile horizon A_2. The Kinbasket soils have a moderately thin Gray Wooded A_2 horizon, whereas the Flatbow soils have leached to greater depth and the Gray Wooded horizon A_2 is podzolized.

A profile was examined near the main highway between Wardner and Jaffray. It is on a north slope at about 2,780 feet elevation. The tree stand is a thick growth of lodgepole pine with scattered larch, and the ground cover is well shaded. The description is as follows:

Horizon	*Depth*	*Description*
A_0	½- 0″	Forest litter. Pine needles, grass etc., fluffy in the lower part.
A_{2p}	0- 2″	White (dry), grayish brown (moist) loam, platy, porous. pH 5·7.
B_{1p}	2- 4″	Very pale brown (dry), yellowish brown (moist) loam to silt loam, weak subangular blocky structure, breaking to granular structure. Porous, firm, gravelly. pH 5·5.
B_{2p}	4- 6″	Brownish yellow (dry), yellowish brown (moist) loam to silt loam, subangular blocky structure, breaking to crumb structure, porous, slightly compact, gravelly. pH 6·0.
C_p	6-11″	Very pale brown (dry), yellowish brown (moist), loam to silt loam, medium subangular blocky structure, breaking to fine aggregates of the same type. Scattered stones and gravel. pH 7·7.
B_{2gw}	11-15″	Yellowish brown (dry & moist), blocky clay loam, compact, scattered stones and gravel. pH 6·9.
B_{ca}	15-21″	Very pale brown (dry), brown (moist) loam to silt loam, angular blocky structure, fairly compact, gravelly, scattered stones and boulders, soil material mixed with bits of till. Calcareous, root mat in lower part. pH 8·2.
C	21″ +	White (dry), very pale brown (moist) loam to silt loam textured, compact till. Contains variable amounts of stones, gravel, grit and scattered boulders. Very calcareous in zone of contact with solum. pH 8·5.

Agriculture

The Flatbow soils are presently used for forest and forest-range. After removal of the mature timber the land produces Christmas trees. Where the topography is favorable and the stone content not excessive, the Flatbow soils are potentially irrigable. Under irrigation the type of agriculture should be mixed farming. The farm duty of water for the irrigation season is about 24 acre-inches.

Land clearing of vegetation and removal of stones and boulders are necessary before cultivation. The forest is of medium density in the greater part of the area, most of the mature timber is logged, and some of the area has been burned over. Stones may require periodic removal until the solum is cleared.

When the land is cleared and cultivated, the addition of organic matter and commercial fertilizers are required to start the first crop. Soil fertility and crop production will increase when deficiencies have been satisfied and the best crop varieties for the climate are used. Sprinkler irrigation is recommended, with light applications of water as required. Excessive use of water will saturate the solum and cause downslope seepage, owing to the impervious substratum. Since exposed subsoil is infertile, care should be taken to avoid erosion.

The possibility of finding well water is limited, owing to the well-drained topography and the impervious nature and thickness of the till. Cisterns will be necessary for storage of domestic water and to water stock when the irrigation system is not in use. Where the till is thick and compact, the water loss is low and cisterns with no linings may be possible.

Under the classification of soils according to their suitability for irrigation, the Kinbasket-Flatbow soil group contains about 3,890 acres of Second Class and 15,032 acres of Third Class land.

NARBOE CLAY LOAM

In the classified area the Narboe series occurs in the upper Kootenay River valley, upstream from Canal Flats. While most of the acreage lies between the Kootenay Park boundary and Gibraltar Rock, there are one or two isolated areas downstream between Gibraltar Rock and Canal Flats.

The elevation of this type is between 3,750 feet, near the Cross River, and 2,800 feet above sea level about 9 miles upstream from Canal Flats. The total area mapped amounts to about 6,302 acres, of which 6,183 acres are classed in several grades as potentially irrigable, and there are approximately 119 acres of excessively stony, non-arable land.

The type has terrace topography, with a gently undulating to gently sloping surface. The slopes are generally inward, away from the river, and there is a gentle downstream slope. The terraces are isolated and also grouped one above another. A Narboe terrace about 9 miles upstream from Canal Flats is noteworthy for the sink holes it contains. These are funnel-shaped depressions of various sizes up to 60 feet or more in diameter and 30 feet deep. They are formed by cave erosion of gypsum deposits beneath the terrace and the filling of the solution holes by terrace gravel.

The main features of the soil profile are a fine textured surface layer above stratified terrace gravels, which may be from a few feet to 50 feet or more in thickness. The surface soil material is derived from the McKay Groups and the Cedrus till. It is mainly clay loam with included small areas of silt loam. The average thickness of the fine material is about two feet, liberally mixed with gravel in the lower part. Gravel has been scattered through the soil to the surface by uprooting trees. On some terraces the fine textured layer is comparatively thin, and where stones form a large part of the underlying stratum, the surface stone is excessive for any cultural purpose.

This well to excessively drained soil type supports a light to medium second growth forest, with some small areas that have no trees. The second growth is mainly lodgepole pine, with a minor inclusion of spruce, fir and larch. The ground cover consists of juniper, kinnikinnick, saskatoon, snowberry, rose, vetch, pine grass and others.

The following profile was examined about one half mile south of Camp 10 on the east side of the Kootenay River, near the valley road:

Horizon	*Depth*	*Description*
A_0	½- 0″	Forest and grass litter, raw on top, well decomposed and black in the lower part.
A_{2p}	0- ½″	Very pale brown (dry), pale brown (moist) silty clay loam, platy, fairly compact, friable, no stones or gravel. pH 6·1.
B_{2p}	½-3½″	Pale yellow (dry), yellowish brown (moist) clay loam, weakly blocky. No stones or gravel. Slightly compact, porous. pH 5·9.
C_p	3½-6½″	Pale yellow (moist) clay loam, fairly compact, porous, blocky, scattered gravel. pH 5·9.
B_{2gw}	6½-7½″	Pale brown (moist) clay loam, weak blocky structure, scattered gravel, compact. pH 7·3.
$B\text{-}D_{ca}$	7½-23″	Pale yellow (dry), yellowish brown (moist) fine to coarse gravels containing clay. Porous, scattered stones up to 6″ diameter, roughly stratified, calcareous. pH 8·1.
D	23″ +	Pale olive (dry) stratified gravels, the material being variable in size, porous, calcareous, excessive drainage. pH 8·0.

Agriculture

Without irrigation this soil type is suitable only for forest and forest-range. Under irrigation the Narboe soils have limited use value, chiefly for sod crops. Cultivation should be kept to a minimum, owing to the thin solum. Potatoes and root vegetables should not be produced.

Under irrigation the land may be used for dairying and beef production, with the land subdivided so that a part of the farm acreage includes another soil type. The farm duty of water is about 20 acre-inches for the irrigation season. Irrigation water must be flumed or piped to points of distribution.

Land clearing for cultivation includes the removal of the medium to light forest and the removal of stones. The most likely method of development is to reclaim the most desirable areas at the start, and gradually the areas of lesser value will come into use as the land increases in value. There was no farm development on this type in 1954.

The Narboe soils would increase in fertility under irrigation as the preliminary deficiencies are overcome. The content of organic matter in the soil should be increased as a means of holding moisture and getting the best yields. Complete fertilizer should be used at the beginning of cultivation to start the first crop.

Under the classification of soils according to their suitability for irrigation, there are about 1,453 acres of Third Class, 4,346 acres of Fourth Class and 384 acres of Fifth Class land mapped as Narboe Clay Loam.

Sparwood Sandy Loam

The Sparwood series developed from calcareous surface materials on the higher and older terraces in the Elk River valley. The bulk of the terraces consist of sands and gravels derived from till, and there is a thin surface covering of finer texture. Like the Michel soils, the parent materials are dark in color.

The Sparwood Sandy Loam occurs on small, scattered terraces between Sparwood and Morrissey, in the humid section of the Elk River valley. The area of highest elevation is about 3,800 feet above sea level near Sparwood. The lowest area is approximately 3,200 feet elevation in the vicinity of Morrissey. The total area mapped amounts to about 857 acres.

The topography is gently sloping to gently undulating. The terraces have a slight inward slope from the river and a general downstream slope. The average surface soil texture in the mapped area is sandy loam.

The climax vegetation has been destroyed by logging and fire. The present forest cover is a medium to heavy stand of lodgepole pine, containing a small amount of fir, larch, aspen and willows. The ground cover consists of oregon grape, snowberry, rose, lupine, vetch, pine grass and others.

The well to excessively drained fine-textured surface soil overlying gravel is from 12 to 16 inches thick. A profile representing average conditions was examined about half a mile east of Sparwood, near the main road to Michel, at about 3,800 feet elevation. The description is as follows:

Horizon	*Depth*	*Description*
A_0	1- 0″	One year's fall of forest litter, including dead grass. Fluffy and dark in the lower part. pH 5·8.
A_{2p}	0- 1″	White (dry & moist) sandy loam, platy, gritty, porous. pH 5·7.
B_{2p}	1- 2″	Yellowish brown (dry) dark yellowish brown (moist) loam, granular, friable, porous, scattered gravel. pH 5·7.
C_p	2-12″	Pale brown (dry), dark brown (moist) sandy loam, large breaking to small crumb structure, friable, porous, gritty, scattered gravel. pH 5·0.
B_2-D_{gw}	12-16″	Dark grayish brown (moist) clay loam, blocky between stones, scattered stones and gravel, porous, friable. pH 5·4.
D_{ca}	16-21″	Dark brown (moist) clay loam in matrix of stones and gravel, the lower part of stones being lime plated. pH 7·2.
D	21″ +	Stratified calcareous gravels to a depth of 20 feet or more containing small amounts of fine material, sand, etc. A considerable inclusion of larger stones and boulders.

Agriculture

Excessively drained soil types, such as the Sparwood series, are marginal without irrigation. However, about 35 per cent of this type is used on a dry farming basis in the vicinity of Hosmer and Fernie. Production consists of moderate crops of oats, hay, alfalfa and pasture. The areas of Sparwood soils are too small for individual farm units, hence they are being used as parts of farms that include other soil types.

The type of agriculture under irrigation should be mixed farming. Piping or fluming of water to points of distribution is necessary, and the farm duty of water is about 18 acre-inches. Well water for domestic use should be obtainable from wells drilled below the elevation of the Elk River.

When the land is cleared, there is a deficiency of organic matter and available plant food elements. Fertilization with manures, crop rotation and commercial fertilizers is required. Land clearing is heavy in parts of the area, and stone removal is necessary where the solum is thin.

The Sparwood and other classified soils developed on gravelly terraces define and locate important areas of gravel and sand deposits. They are a source of material for road building, and most terraces have gravels and sands suitable for making concrete.

Under the classification of soils according to their suitability for irrigation there are about 552 acres of Third Class land with a moderately deep solum, and 305 acres of Fourth Class land having limited value, owing to a thin solum overlying gravel.

Crahan Sandy Loam

This soil type is derived from dark, calcareous, stone-free sands. The lime inclusion is from glaciation of Paleozoic limestones that overlie the younger Fernie and Kootenay formations, which supplied the sands. The parent material was distributed as a delta near the shore of a temporary glacial lake. Subsequent erosion has dissected the area of the delta into several parts.

The type occurs in the Elk River valley to the north of the Fording River at elevations that lie between 4,100 and 4,400 feet above sea level. This is one of the minor soil types, with a total of about 5,141 acres in the mapped area.

The topography is from gently to steeply rolling, owing to the comparatively thin sandy deposit over the underlying till. There is a gentle to steep slope towards the valley center. The texture of the Crahan Sandy Loam does not vary to any marked degree in the mapped area and the type is well drained.

The native vegetation is composed of heavy mature lodgepole pine gradually being replaced by spruce. The plant growth also includes a well-shaded shrub layer of snowberry, rose and blueberry. On the ground there is a good cover of feather moss, scattered reindeer moss, lichens, fungi and pine grass.

The soil is leached to yellowish brown in the lime-free part of the solum. In the lower part, where lime exists, the dark grayish brown color of the parent material is dominant. A soil profile was examined at about 4,250 feet elevation opposite Martin Creek, on the east side of the Elk River about 16 miles north of Natal. The description is as follows:

Horizon	*Depth*	*Description*
A_0	2- 0″	Feather moss, reindeer moss, needles, twigs, leaves, etc. Black and well decomposed in the lower part.
A_{2p}	0- 2″	White (dry), light brownish gray (moist) sandy loam, platy, ashy, porous. pH 5·0.
A_{3p}	2- 5″	Yellowish brown (moist) sandy loam, weakly plated, fairly compact. pH 5·5.
B_p	5- 8″	Brown (moist) sandy loam, subangular blocky structure, firm, porous. pH 5·5.
C_p	8-18″	Very pale brown (dry), yellowish brown (moist) sandy loam, weak subangular blocky structure, breaking to single grain structure. pH 6·0.
B_{2gw}	18-20″	Dark yellowish brown (moist) sandy clay loam, blocky, compact. pH 6·6.
B_{ca}	20-32″	Very dark grayish brown (moist) loamy sand, massive, compact, calcareous. No stones or gravel. pH 7·9.
C	32-40″	Dark grayish brown (moist) stratified loamy sand, no stones or gravel. pH 8·0.
D		Gravelly calcareous till at various depths, lime plated stones at the top.

Agriculture

The Crahan Sandy Loam is not recommended for agriculture without irrigation, owing to the summer-dry climate. There is no cultivated acreage on this soil type at the present time. If irrigated, the soil would produce crops that can be grown under prevailing climatic conditions. These are chiefly hay, grain and cool season vegetables. With proper management, the type could be used for beef production and dairying.

As new land ready for irrigation and cropping, the preliminary deficiencies are organic matter, nitrogen, phosphorus and potash. Trace element deficiencies may occur after years of farming. After preliminary fertilization to give the first crops a start, the fertility of the land will gradually increase.

Large irrigated farms are required to pasture and winter feed the livestock, without depending on vacant land for pasture. Irrigation water should be flumed or piped to points of distribution. Open ditches in the soil itself would bring excessive loss of water from seepage. The farm duty of water is approximately one acre-foot. Drainage problems may occur where the till substratum is close to the surface.

A domestic water supply from wells is unlikely, owing to the impervious nature of the underlying till. However, the till is a suitable medium for unlined cisterns to supply water when the irrigation system is not in use.

Under the classification of soils according to their suitability for irrigation there are about 120 acres of Third Class and 4,487 acres graded as Fourth Class land. Adverse topography is the reason for low grading. An additional 534 acres are classed as rough, broken and non-arable.

5. Brown Podzolic Soils

The existence of Brown Podzolic soils in association with Gray Wooded and Podzolized Gray Wooded soils in the most humid part of the mapped area is due to low lime content in two kinds of parent materials. No free lime in parent material should cause an Azonal soil to develop directly to a Brown Podzolic soil under these conditions.

In the mapped area, Brown Podzolic soils have distinctive general characters, as shown in the following description:

Horizon	*Description*
A_0	Accumulation of forest litter from one to two inches thick.
A_2	White to grayish brown, platy; often thin or absent, seldom more than one inch thick in localized areas.
B_{21}	A thin layer generally not more than one inch thick. Yellowish brown, granular.
B_{22}	Pale yellow, granular to weak subangular blocky structure, from eight to sixteen inches thick.
B_3	Olive, with subangular blocky structure, four inches or more in thickness.

A thin A_2 horizon may or may not be present. Horizons B_{21} and B_{22} have several shades of color from reddish brown to olive, under different conditions of climate and parent material. Variable amounts of iron and aluminum accumulate in horizon B, but there is no accumulation of clay in this horizon. The reaction may be moderately acid throughout the solum, or rather strongly acid at the top and moderately acid in the lower part. The Brown Podzolic soil is regarded as a weakly defined podzol that may eventually become a true podzol.

Only two Brown Podzolic soil types, Cokato Clay Loam and Wardrop Sandy Loam, were mapped. They occur in the humid part of the Elk River valley, around Fernie and Morrissey. One is a fine-textured soil that developed on loose till, and the other is derived from kame sands.

Cokato Clay Loam

The Cokato series is derived from non-calcareous glacial till. It occurs in the Elk River valley, the largest areas mapped being around the mouth of the tributary valley of Hartley Creek, a few miles north of Fernie. Other areas are located in the humid section between Fernie and Morrissey.

The range of elevation is between 3,250 and 3,900 feet above sea level, and the total area mapped amounts to about 2,035 acres. The topography varies from gently to steeply rolling, with general slopes towards the valley center. The type is well drained.

The till, from which this soil is derived, was eroded by tributary valley glaciers from the Fernie and Kootenay formations, and pushed into the Elk River valley. The till materials consist of partly decomposed yellow and black shales, soft sandstones, shaly boulders and scattered, rounded stones of more durable quartzite and argillite rock, all of which is in a loose mixture. It differs from other tills in the mapped area by a lack of compression. The stone content is moderate and unlikely to interfere with agricultural development. The soil texture varies from loam to clay loam, the average being clay loam.

The native vegetation is secondary and of medium to heavy density, depending on the time elapsed since each area has been logged or burned. It is chiefly larch, spruce, white pine, lodgepole pine, cottonwood, willow and aspen in variable mixtures. The ground is covered by a thin layer of leaves and other debris, including old logs and stumps. Clearing is heavy.

A profile was examined near Hartley Creek, about one half mile from the main highway at 3,810 feet elevation. The description is as follows:

Horizon	*Depth*	*Description*
A_0	1- 0″	Forest litter; leaves, needles, twigs, wood, etc., well decomposed in the lower part.
A_2	0- 1″	White (dry) grayish brown (moist) loam, platy, porous, friable, scattered stones and gravel. pH 6·2.
B_{21}	1- 2″	Light yellowish brown (dry), dark yellowish brown (moist) clay loam, granular, friable, scattered stones. pH 5·7.
B_{22}	2-10″	Light olive (dry), olive (moist) clay loam, coarse subangular blocky structure breaking to smaller sizes of same shape. Scattered bits of black and yellow shale, porous. pH 5·1.
C	20″ +	Till that lacks compression; composed largely of yellow and black shale, decomposing to yellowish and black clay loam in pockets. Sandstone, pebbles of stratified clay, scattered hard stones and gravel. Pieces of shale are weakly calcareous at a depth of 60″. pH 5·1.

Agriculture

Farming of the Cokato Clay Loam is restricted to a few small clearings, owing to the high cost of taking off the growth of vegetation. While moderate crops are obtained by dry farming, the maximum production cannot be achieved without irrigation and good management.

With irrigation the Cokato series may be regarded as arable for the production of hardy crops, such as hay, legumes, grain and vegetables. While the land is new it may be used for specialized seed growing.

The organic matter deficiency could be supplied by barnyard and green manures and sod crops. If sawdust is used, ammonium nitrate should be added to help decomposition. The use of complete fertilizer and lime on this soil type is essential.

The farm duty of water for the Cokato series is approximately 16 acre-inches. Aside from an occasional spring, groundwater is more or less unavailable. Cisterns may be required for the domestic water supply when the irrigation system is not in use.

Under the classification of soils according to their suitability for irrigation, there are about 545 acres of Third Class and 1,409 acres of Fourth Class land, the low grades being chiefly due to the topography. An additional 81 acres are excessively stony and non-arable.

Wardrop Sandy Loam

This type consists of a group of non-calcareous sandy soils derived from kame sands. They occur on both sides of the Elk River valley in the humid section between Fernie and Morrissey. The sands appear to have slumped over the glacio-lacustrine clay from which the Abruzzi series is derived.

The range of elevation is from 3,150 to 3,350 feet above sea level, the lowest area being near Morrissey Creek and the highest between Lizard Creek and Fernie. This type is a minor one, with a total area of only 846 acres.

The topography is gently rolling to rolling, with a general slope towards the valley center. There is good to impeded drainage, depending on the depth of the underlying clay. Soil textures vary from loamy sand to loam, sandy loam being the most common.

The native vegetation is a heavy secondary growth of spruce, cedar, birch, alder, cottonwood, willow and aspen. There are large cedar stumps up to four feet in diameter, indicating the size of the original trees. The shrubs include rose, salmonberry, snowberry, and others. Where shade is sufficient, the ground has a moss cover.

The soil profile was examined about a half mile south of the Morrissey bridge over the Elk River. The description is as follows:

Horizon	*Depth*	*Description*
A_0	2- 0″	Forest litter in two well defined layers, a raw layer of needles, twigs, leaves and moss, and a well decomposed layer beneath.
A_2	0- 1″	Very pale brown (dry), brown (moist) sandy loam, platy, ashy, porous. Sometimes absent. pH 5·5.
B_{21}	1- 2″	Yellowish brown (dry), dark yellowish brown (moist) sandy loam, granular, fluffy, many roots. pH 5·6.
B_{22}	2-18″	Pale yellow (dry), light olive (moist) sandy loam, weak subangular blocky structure easily broken down, porous, friable. pH 6·6.
B_3	18-22″	Olive (moist) sandy loam, subangular blocky structure, a tight horizon that may impede drainage. pH 6·8.
C	22″ +	Very dark grayish brown (moist) loamy sand, massive, no stones or gravel, pH 7·0 in the upper part. At 40″ there is a sandy clay loam horizon beneath which free lime occurs around the channels of old roots.
D		Stratified glacio-lacustrine clay at various depths, but generally of sufficient depth to be of no importance to the soil above. In some places the clay may be close enough to the surface to impede drainage.

Agriculture

An area of the Wardrop soil is cultivated on the west side of the valley, and fair yields of hay are produced. The crops, however, are checked by the summer-dry climate, and the soils cannot give their maximum yields without irrigation. Under present conditions the cost of land clearing of the heavy growth on this type is excessive, but when ready for the first crop there should be a liberal application of manure and commercial fertilizer. The use of lime may be necessary.

Under irrigation the type of agriculture should be mixed farming. The farm duty of water is approximately one acre-foot. To avoid loss, irrigation water should be flumed or piped to points of distribution, and the use of sprinklers on this soil type is recommended as a means of minimizing erosion.

Where clay underlies the Wardrop soils, domestic water should be available from properly located wells. The wells will receive water from the sand-clay zone of contact. They should be dug into the clay for the required area of accumulation and storage.

Under the classification of soils according to suitability for irrigation, there are 801 acres of Third Class and 45 acres of Fourth Class irrigation land in the mapped area.

6. Soil Complexes

The Wigwam Soil Complex

This Complex developed on alluvial fans and the fan-like deposits of streams entering the main rivers. The composition of the fan materials depends on the nature of the rocks from which the fan has eroded. Some of the fans are derived from limestones and some from non-calcareous sedimentary rocks. The inclusion of calcareous stream deposits was conditioned by an acreage too small for differentiation as a separate type. A considerable part of the area of calcareous stream deposits is composed of calcareous gravels and stony outwash of no agricultural value.

The Complex occurs throughout the Upper Kootenay and Elk River valleys, at elevations between 2,400 and 4,100 feet. There are many small, scattered areas amounting to about 26,808 acres.

The topography is characteristic of the slopes of fan cones and gently sloping stream deposits. The fans radiate from the mouths of mountain coulees, and occur at the toe of the mountain slopes. The main slope of the fan cone is at the center and outward, with lateral slopes to right and left, all slopes ending at the margin of the fan apron. The topography is gentle and suitable for irrigated agriculture where the land is not too stony.

The parent materials, often fine textured, belong to the post-glacial erosion cycle. This stage began after the glaciers had retreated into the mountains and the present level of runoff was established. Before the terrain was protected by vegetation there apparently was a period when storms and "cloudbursts" caused tumultuous runoff, which moved large amounts of material from the valleys of small temporary and permanent streams.

Fan construction came about in two different ways. In one process large amounts of material at higher elevations near the fan site became water saturated to the point of flowage. This material caved into a stream valley and crept or poured into the area of a fan as a thick, unsorted mass.

This type of fan is usually built in a single movement. Subsequently a single stream channel is cut through the fan to drain the coulee during the freshet season. If stones are included in the parent material, they are distributed uniformly in the mass and over the whole area of the fan.

The second and more common way of fan construction is by a succession of exceptional freshets, each of which contributed sorted material transported for some distance. The length of time between stages of fan building may be long or short. The long extreme may be once in a century or more, while in some cases fans may receive additions of material annually. Where the fan is built in stages, the material is graded as to size. Stones and gravel are deposited at the apex of the fan, and this may grade down to stone free silt in the lower part of the fan apron.

The second process of fan formation has a stream channel for each stage of building, which drains off the surplus water. Each outwash and addition of material buries the channel that relieved the former one and erodes another shallow run-away down any part of the main slope. The buried channels are bedded with porous gravel about a foot or more thick and from a few feet to 20 feet in width. They are scattered from bottom to top in the vertical section of the fan, and they act as seepage-ways for underground water. If the fan overlies impervious material, the drainage water outcrops along the fringe of the fan apron. Thus formed, springs may produce beds of marl or areas of peat or swamp. Under the same conditions excess irrigation water may saturate a considerable part of the fan apron, so that the lower part of the fan will require drainage. The coulee that feeds each fan contains a spring or small stream. A stream may be tapped at the mouth of the coulee for irrigation or a domestic water supply. Quite often, however, the bulk of the stream water is allowed to escape into the stony top of the fan, and drain through buried channels as described above.

The texture profile at the top or upper third of the fan may consist of angular stones of many sizes, with sufficient sandy loam, loam or silt loam between them to provide rooting for trees. This type is classed as excessively stony and non-arable. Farther down to the centre of the fan the common soil texture is sandy loam or loam, with stones or gravel scattered in the solum. The lower half or third of the fan may be stone free between runoff channels, with soils developed on loam, silt loam, clay loam, or clay materials.

The drainage channels radiate downward from the apex to the outer fringe on fans of all sizes, and their interference with cultivation varies with the stone content of the fan. Gravelly fans have gravelly outwash channels which serve to cut the area into separate fields, whereas in fine textured fans the channels may be suitable for cultivation. In large gravelly fans, channels may be of considerable width and their texture profiles can differ from those on other parts of the fan.

The native vegetation varies with the different conditions of climate, the texture of the whole soil profile and drainage. Scattered trees and grass grow on thin, stony profiles and in dry areas. Fine-textured fans support a medium forest in most sections to the south of Canal Flats in the Rocky Mountain Trench. The growth is heavy on fans in the humid parts of the Elk River valley. In all sections the fans support the same native vegetation mentioned in descriptions of cover under the different soil type headings.

The soils derived from fan parent materials are at several stages of development. Young or A-C profiles grade into Dark Brown soils, Brown Wooded soils and Gray Wooded soils on different fans or on parts of fans. Fans that receive more or less frequent additions of material have the youngest soils. Those with medium development of profiles have an occasional covering of new material, or they occur in a dry area. Some fans have achieved stability and well developed profiles. Where additions come at long-spaced intervals, there may be a series of buried soil profiles in the fan deposit.

The Wigwam Soil Complex is capable of differentiation into its component soil series and types when a more detailed scale of mapping is used. Under some of the existing conditions, groups of fans and single fans can be defined as separate soil series. In some cases there may be two or more soil series on a single fan, due to different profiles and drainage conditions, or a soil series may occur on one part of a number of fans. During the process of soil mapping, it was found that several members of this Complex have sufficient area for separation with the present map-scale. These were differentiated and named Lakit, Kokum, Madias and Nestor series and Meadow. The separated members of the Wigwam Soil Complex were described and placed under their respective soil group headings in this report. These descriptions will serve to explain some of the features that occur and how members of the Complex differ from one another.

Agriculture

The Wigwam Soil Complex is submarginal for agriculture without irrigation, owing to the summer-dry climate. Many fans, however, have small permanent streams, which are used to irrigate some of the arable acreage.

Excessive amounts of stones on the upper parts of many fans have the effect of limiting the areas suitable for irrigated agriculture. The arable land is generally situated in finer-textured areas around the lower part of fan aprons. When irrigated the fine-textured and comparatively stone-free areas produce good crops of hay and vegetables. Some of the fans slope down to the lowest elevations in which they occur, and their lower parts are covered by cold air at night in clear weather. Such areas have limited value for the production of frost-tender vegetables.

Streams associated with fans and used for irrigation, often come directly from melting snow at high elevations. The water may be received into the irrigation system at a temperature near 40°F., for the irrigation of vegetable crops and pastures. Under climatic conditions where seasonal heat is limited, it would be an advantage to pond this water if possible, and allow it to gain in temperature before irrigating.

With irrigation the type of agriculture should be mixed farming. The average farm duty of water for the Complex is about 30 acre-inches. The water requirement may be more or less in cases of very coarse or very fine textured profiles. In order to avoid loss the irrigation water should be flumed or piped to points of distribution. The sprinkler method of irrigation is advisable for land devoted to hay crops.

A domestic water supply is sometimes available from springs or streams that enter at the apex of the fans, or from seepage around fan aprons. In some areas cisterns will be required for water storage when the irrigation system is not in use.

As new land ready for cropping the Wigwam soils are deficient in available plant food. Manuring and the use of a complete fertilizer is advisable before the first crop is planted. Alfalfa, confined to the best drained areas, requires inoculation when seeded on new land. After preliminary fertilization the growth and yield of crops will gradually increase.

The Wigwam soils are the most extensively developed for irrigated agriculture in the Upper Kootenay River valley, owing to availability of stream water flowing through some of the fans. In the vicinity of Roosville, near the border of Montana, a group of fans occur with west exposure well above the valley bottom, thus affording maximum summer heat and good air drainage.

Under these favorable conditions, tree fruits, vegetables and even tomatoes are produced. Some of the tree fruit varieties are too tender for survival through the winters, and they show excessive trunk injury and root damage, but Wealthy and McIntosh apple trees appear comparatively uninjured, and their fruit is of good color and quality. The largest orchard covers about 8 acres on a high fan. It is furrow irrigated, pruned, sprayed and fertilized. The worst orchard pests are apple scab and deer. In the nearby valley bottom the Wigwam soils produce good crops of alfalfa, hay and grain.

Under the classification of soils according to their suitability for irrigation there are about 203 acres of First Class, 15,127 acres of Second Class, 2,615 acres of Third Class, 2,510 acres of Fourth Class and 166 acres of Fifth Class land. In addition, approximately 6,187 acres in the total of 26,808 acres are excessively stony and non-arable.

7. Groundwater Soils

The soils affected by groundwater are grouped in this report as Groundwater soils. They are separated into (*a*) mineral soils developed on flood plains and second bottoms of rivers and (*b*) bog soils.

The mineral soils were differentiated into the Crowsnest and Salishan series on the basis of a difference in parent material. Both these series vary from imperfectly to very poorly drained positions depending upon the annual rise and fall of the river and the relative elevations of the floodplains and river bottoms. The profile consists of a thin horizon A with slightly weathered parent material beneath. These soils are Azonal, and their lack of profile development is due mainly to youth. They are still receiving periodic additions of sediment.

The bog soils are found mainly in depressions in the till-plain where the underlying strata is sufficiently impervious to maintain ponded or very poorly drained conditions. Ponding permits the growth of a succession of water-tolerant plants. Water lilies, rushes and sedges are the first to appear. When their remains have accumulated to a sufficient height, moss and finally shrubs and trees invade the area. These bog soils were classed as Muck.

(A) Mineral Soils with Restricted Drainage.

Crowsnest Sandy Loam

The Crowsnest Sandy Loam developed on first and second bottoms of the Elk River. It occupies the lowest of a series of terraces from which the Michel, Cadorna and Sparwood soils are derived. The dark colored, fine textured, calcareous material that overlies gravel has a thickness that varies from a few inches to six feet or more in different places, but the average depth is around two and one half feet.

A thin top layer of fine texture occurs where high velocity of water flow prevented greater deposition. Areas of this phase, which have no agricultural value, are located over the whole length of Michel Creek in the mapped area, and in parts of the Elk River valley. The total area mapped amounts to about 13,076 acres.

The bottoms capped by the Crowsnest series lie adjacent to the Elk River throughout its length in the mapped area, and they vary in height from a few feet to 10 feet or more above the average river level. The elevation of the highest second bottoms are in the northern part of the Elk River valley, where they occur up to 4,350 feet above sea level. The lowest elevation is about 2,400 feet, where the Elk enters the Kootenay River.

The topography is gently sloping and undulating, with included scars left by the abandoned arms of the stream. There are occasional areas with hummocky micro-relief, caused by heaps of material left by generations of uprooting trees. The soil, which is more or less stone-free, varies from sandy loam to clay loam, sandy loam being the most common.

The native vegetation is of medium to heavy density, depending more on stages of growth due to logging or fire than to lack of moisture. The trees are mainly second growth spruce, cedar, lodgepole pine, cottonwood, birch, willow and aspen. A few cedar around Morrissey are about 4 feet in diameter, but most of the original timber is gone. Rotting logs are numerous. There is a luxuriant shrub layer, and a ground cover of vetch, strawberry, weeds, grasses and scanty moss.

A soil profile was examined about 5 feet above river level near Hosmer, at 3,475 feet elevation. The description indicates slight development. Under these conditions uprooting trees often damage the A horizon, which may in places show greater depth.

Horizon	*Depth*	*Description*
A_0	2- 0″	Leaf litter, needles, dead wood. Well decomposed in the lower part.
A	0- 2″	Light brownish gray (dry), very dark grayish brown (moist) sandy loam, weakly plated, porous, no stones or gravel, many small roots. pH 7·4.
C	2″ +	Light brownish gray (dry), very dark grayish brown (moist) sandy loam, stratified, no stones or gravel. Penetrated by roots. This horizon varies from one to several feet in depth over porous gravel. pH 7·6.

Agriculture

The Crowsnest series is arable without irrigation where the depth of fine-textured material over gravel is satisfactory for the purpose of cultivation. There is a greater acreage of Crowsnest soils under cultivation than any other soil series in the Elk River valley. Crop yields are good because moisture is not a limiting factor. The principal crops grown are alfalfa, hay, pasture and coarse grains.

Land clearing is heavy and expensive. It involves the removal of trees, old logs, partly decayed stumps and brush. When cleared the land is deficient in organic matter and available nutrients required by the first crop. Under these conditions it is advisable to apply manure and commercial fertilizer as part of the reclamation procedure. The cultivated land would also benefit from the use of commercial fertilizers.

A domestic water supply is available from comparatively shallow wells. Any dry areas on the farm could be irrigated from wells or from the river. Farm buildings should be located on high ground, owing to the possibility of inundation during exceptional freshets.

The type of agriculture should be mixed farming. Large farms are required owing to the short growing season and the long winter feeding period. The heavy snowfall in the humid sections of the Elk River valley calls for better than average winter housing of livestock.

In the Crowsnest series there are approximately 9,674 acres of cultivated and potentially arable second bottoms that can be farmed without irrigation. There are also about 1,505 acres of non-arable first bottoms and 1,897 acres of inaccessible and non-arable second bottoms.

Salishan Silt Loam

This series consists of a group of groundwater soils that occur on the bottoms of the Kootenay River to the north of the Montana boundary. In this area they occupy about 28,694 acres, the average surface texture being silt loam. The height of these soils above average river level lies between the height of the second bottom and the swamp. The range of elevation is from about 3,625 feet near the Kootenay National Park boundary to 2,680 feet at Canal Flats and 2,310 feet elevation at the border of Montana. The topography is gently sloping and gently undulating.

Southward from the Kootenay National Park to Canal Flats, there are about 1,040 acres of potentially arable bottoms and 330 acres that are non-arable. In this area the river is downcutting its bed, and the second bottoms are being eroded.

South from Canal Flats to Skookumchuck, the Kootenay River has a fairly fast rate of flow and the deposits consist chiefly of small islands surrounded by gravel and sand bars. Of two extensive second bottoms that occur, one is just below Canal Flats and the other is near Torrent station. The islands and second bottoms are covered by spruce and scrub willows, and no extensive sedge meadows occur.

Between Skookumchuck and Wardner the river channel has considerable width and the bottoms have the appearance of floodplains. There is a levee along the river bank supporting conifers and cottonwood. Inward from the levee is a gentle loss of elevation, and the tree growth changes to willows. Farther in, the surface-approaching water table limits the natural growth to sedges, and finally a rush swamp occurs near the inner margin of the floodplain.

The swamp and sedge areas are normally subject to flood during the annual freshet, which often invades the willows, but the levee is generally above high water. The natural breaks in the levee permit the invasion of the swamp and sedge areas by the freshet and a temporary lake is thus formed. The fine silt and clay carried at the surface of the freshet is brought in to settle from the quiet water of the floodplain lake. It appears that the sedge and swamp areas of the floodplain accumulate the fine sediments of the river load, whereas the levees are formed of sandy materials.

In parts of the bottomland area between Skookumchuck and Wardner are combinations of floodplain, second and first bottoms. Below Wardner, the river channel narrows and the valley lands consist chiefly of second bottoms connected with the sides of the channel, islands at second bottom height and first bottoms.

Second bottoms are more or less undulating river deposits above average freshet level, but subject to exceptionally high water. First bottoms are covered by the annual flood. Neither the second or first bottoms have the inward slopes of the floodplain, their general slope being downstream.

The parent materials of the soils consist mainly of calcareous fine sands, silts and clays derived from the Wycliffe and Cedrus tills and the erosion of limestones in the Rocky Mountains. The silts and clays are a modern deposition of the same kind of materials from which the Mayook series is derived. Soils derived from the floodplains consist of fine sandy loam on the levees, and silt loam and clay in the areas of sedge and swamp. On second bottoms the main soil texture is silt loam.

The native vegetation is a mixture of spruce, cottonwood, aspen, alder willow and shrubs on second bottoms and levees. There are open sedge meadows in areas subject to temporary flooding and the swamps contain rushes or water lilies, according to the depth of water.

A profile was examined on the river flats in the Indian Reserve to the east of Rampart. There is an extensive floodplain in this locality, partly forested and in part covered by open meadows. The inward slope from the river is gradual, with hummocky clay soil instead of a swamp near the side of the river channel. The profile pit was dug at the highest elevation in forest to get maximum development of the soil horizons. It is described as follows:

Depth	*Description*
0–1″	Mixture of forest litter and river silt from the 1948 flood.
1–2″	Light brownish gray (moist) silt loam, platy, porous. Sediment from an earlier flood.
2–5″	Dark grayish brown (moist) silt loam, weak crumb structure. An old A_0 converted to A_1 by decomposition of organic matter, porous, friable, calcareous. pH 8·4.
5″+	Light olive gray (moist) silt loam, weakly stratified and penetrated by roots. Firm but porous. pH 8·4 to pH 8·9 in different places.

Agriculture

In the bottom lands there are 38 farms with about 2,850 acres under some form of cultivation. This acreage is scattered on the higher second bottoms not subject to flooding in average freshets, but it was inundated during the 1948 flood.

There is no doubt that many of the river floodplains and second bottoms could be dyked and used for the production of hay, but owing to the wide range of river fluctuation, and the restriction of flow imposed by dyking, it is doubtful if dyked areas could be made safe from flood without extensive work.

In the area between Canal Flats and Montana, agricultural reclamation of the river bottoms and floodplains could be sacrificed in favor of using the river channel as a reservoir for river control and development of hydro-electric power. Such development would add to the economy of the region by making water available to irrigate lands along the shores of the reservoir. Damsites at Libby in Montana, and just north of the Bull River would flood the Kootenay River channel from the 49th parellel to Canal Flats. Such development would inundate about 27,324 acres of Salishan soils, of which approximately 23,120 acres are potentially arable.

In a total of about 28,694 acres, the amount of land that would be arable if dyked and otherwise reclaimed amounts to approximately 11,371 acres of floodplains and 12,789 acres of second bottoms, or 24,160 acres. In addition, there are 1,440 acres of non-arable first bottoms and 3,094 acres of inaccessible and non-arable second bottoms.

(B) Bog Soils

Muck

In the mapped area, the Bog soils cover small acreages in the Rocky Mountain Trench, chiefly in the locality between Wardner and Jaffray, and east to the Rocky Mountains. The bogs occur in depressions in the till-plain, at elevations between 2,700 and 3,000 feet, the total area being about 1,057 acres.

The bog formation consists of accumulation of the remains of bog-forming plants such as rushes, sedges and moss. This process has built up well-decayed material in depressions of variable size. Since the plant remains at the surface are decomposed to a stage where they cannot be recognized, the material is classified as Muck.

Important features common to all bogs include similarity of plant remains and a more or less uniform stage of decomposition. The thickness of the organic material varies from one to many feet, and the bottom of the bog is in direct contact with the underlying geological stratum. No marl deposits were observed.

The surface vegetation consists of black spruce around the edges of some of the bogs, and there is a variable cover of bog birch, the density depending on drainage. The ground cover consists chiefly of sedges, with the inclusion of moss. The reaction at the surface and throughout the profile is nearly neutral.

The largest bog in the mapped area, situated to the southeast of Galloway, was cross-sectioned with a special peat sampling tool and the profile is described as follows:

Horizon	*Depth*	*Description*
1	0-69"	Very dark brown to very dark grayish brown (dry), black to very black brown (moist) muck, well decomposed. Finely divided organic matter with unrecognizable plant remains. pH 6·2. There are a few recognizable remains at 30", then continuation of the muck material to 65" where a ¼" layer of diatoms or clay occurs. Beneath this layer to 69" the muck is continued. pH 6·5.
2	69-73"	Very dark grayish brown (dry), very dark brown (moist) peat that is almost muck. There are a few scattered and recognizable plant remains. pH 6·0.
3	73-88"	Light gray (dry), dark gray to dark grayish brown (moist) very fine sandy loam, with a few faint iron stains in the sandy material. pH 7·5.

Agriculture

There is no agricultural development of the Muck bogs in the mapped area. However, they are composed of approximately the same organic material at the same stage of decomposition as the bogs in the North Okanagan valley. They differ as to elevation, a shorter growing season and greater ability to accumulate cold air in their depressions during the growing season.

In the Okanagan valley the similar bog soils have been drained, fertilized and irrigated. They produce heavy crops of high quality celery, lettuce, cabbage, and other vegetables. Partly drained areas are used for the production of hay and grain, which give good yields when fertilizers are used. While the use of the bogs in the mapped area is more limited than those of the Okanagan valley, they could be reclaimed for the production of hay and hardy vegetables. In a partly drained stage the bogs are arable without irrigation, but any areas that are well drained should have sprinkler irrigation.

8. Miscellaneous Areas

Meadow

A few natural alpine meadows occur in the upper Kootenay River valley above Canal Flats, at elevations that exceed 3,500 feet. They are small and scattered, the sizes being from one to 10 acres, and the total area mapped amounts to about 15 acres. Since the meadow type occurs on fans, it may be regarded as a member of the Wigwam Soil Complex.

The fan materials are calcareous, fine textured, and the slopes are gentle. There is evidence that the fans were built in a series of more or less uniform layers, and that seepage plays a role in the meadow formation. The soil is damp and a groundwater table exists during the early part of the year.

The native vegetation on these fans may alternate from forest to meadow, depending on the group of plants that can seize the site after a severe burn. Examination of the cross-section indicates a series of buried soil profiles, some of which developed under grass and some were forest soils.

When the forest is subject to a severe burn, the topsoil is exposed and eroded by summer storms and the annual freshet. Material is thus provided for a new layer of soil over the fan, which buries the former soil profile. If grasses gain a foothold in the damp soil they can compete with a new forest, and a natural meadow is able to survive.

The native vegetation of the meadow consists of several species of grasses, strawberry, vetch, bull thistle and other weeds. The growth is very dense and highly prized by the elk and deer. There is a sharp division between the meadow and the surrounding forest, which consists of spruce, lodgepole pine and aspen.

A profile was examined in a meadow on the west side of the valley, about three and one half miles south of the Kootenay National Park boundary, at 3,640 feet elevation. This profile is described as follows:

Horizon	*Depth*	*Description*
A_0	1- 0″	Olive gray (dry), dark olive gray (moist), matted moss, dead grass and grass roots. Tough, peaty.
A_1	0-1½″	Very dark gray (dry), black (moist) silt loam, fine granular structure, porous, no stones or gravel. pH 5·4.
B_1	1½-2½″	Brown (dry), dark grayish brown (moist) silty clay loam, crumb structure, firm, porous. pH 5·5.
B_2	2½- 6″	Brown (dry), dark grayish brown (moist) silt loam, granular, less firm than B_1, many roots. pH 7·1.
B_{3ca}	6-14″	Brown (dry), dark grayish brown (moist) loam, subangular blocky structure, calcareous. pH 7·9.
C_{ca}	14-17″	Light brownish gray (dry), dark grayish brown (moist) silty clay loam, blocky structure. pH 8·1.
(Buried Profile) A	17-19″	Reddish brown (dry & moist) clay loam, angular blocky structure, burned topsoil of an old forest; charcoal at the site of old roots, weakly calcareous.
B_1	19-22″	Brown (dry), dark brown (moist) clay loam, angular blocky structure, soft, porous, weakly calcareous.
B_2	22-30″	Light brownish gray (dry), dark grayish brown (moist) silt loam, massive, spots and veins of free lime around old roots, very calcareous.

The cross-section continues through two additional buried profiles which are more compressed than those described above. The lower profiles repeat the description of the buried profile here described. They include reddish or burned A horizons containing charcoal.

Agriculture

The Meadows are arable without irrigation. They are not used for any agricultural purpose at present, owing to their isolation and small size. As parts of farms they would be available for use without land clearing.

SWAMP

Swamps on the river floodplains have been included as part of the acreage of floodplain soils. In other parts of the mapped area there are approximately 2,566 acres mapped as Swamp. The total includes about 702 acres in the Kootenay River valley, between Canal Flats and Kootenay National Park, 1,095 acres in the Rocky Mountain Trench to the south of Canal Flats, and 769 acres in the Elk River valley.

The Swamps consist of small, shallow, ponded depressions in various stages of bog formation. In shallow ponds, rushes may cover the whole area. Deeper parts of a pond may have open water or a cover of water lilies. Ponds that become dry during the summer season may have sedge bottoms.

Agriculture

Swamps are capable of conversion to agricultural land when they are adequately drained, aerated and fertilized. Under these conditions they can be made to produce frost-hardy crops such as hay. Since they occur in frost pockets, the reclaimed swamps should be regarded as limited use soil areas. In their natural state the Swamps are regarded as non-arable land.

Water

In the mapped area the acreage covered by lakes is relatively unimportant, but rivers occupy a considerable acreage. The area of river bottoms occupied by moving water in the area mapped amounts to about 22,968 acres.

Placer Tailings

The area at the mouth of Wild Horse Creek, where it enters the Kootenay River, was mapped as Placer Tailings. The Placer Tailings consist of an outwash of gravels which covered the former creek deposits. They were produced by the hydraulic mining of the creek banks for gold. The area covered by Placer Tailings in the channel of Wild Horse Creek amounts to about 288 acres. This land has no agricultural value.

Concentrator Dump

The Sullivan Mine Concentrator near Kimberley handles about 9,000 tons of ore per day. This is reduced by the ball mills to silty rock flour. After the minerals have been removed the waste is flumed into a large dump covering about 622 acres. The land covered by the waste material from the Concentrator has been destroyed for any agricultural use.

Bluffs and Ravines

The Bluffs and Ravines fringe the channel of the Kootenay River and its tributaries, and they consist of the eroded steep slopes of the deeply cut water courses. This type of land, which occupies about 30,369 acres, is too rough for agriculture, but it has some value for range and forestry.

Rock Outcrop

In most parts of the mapped area the bedrock is completely covered by glacial till and older materials. Rock Outcrops are more or less infrequent and the exposures are small. Where they occur the Rock Outcroppings are located on the soil map by means of a symbol. No Rock Outcrops were mapped in the upper Kootenay River valley above Canal Flats or in the Elk River valley. About 436 acres of Rock Outcrops were mapped in the Rocky Mountain Trench to the south of Canal Flats. They have no agricultural use.

Rough Mountainous Land

Rough Mountainous Land covers about 280,896 acres in a number of separated areas. Most of this land consists of mountainous ridges and hills within the Rocky Mountain Trench. The topography is steep and there are many acres of exposed bedrock. This land has some value for range and forest.

TABLE 4. APPROXIMATE ACREAGES OF DIFFERENT SOILS

Soils	Potentially irrigable	Arable without irrigation	Non-Arable	Total
	(Acres)	(Acres)	(Acres)	(Acres)
Plumbob Silt Loam	8,403		1,903	10,306
Saha Silt Loam	10,057			10,057
Hyak Sandy Loam	5,509		7,977	13,486
Wycliffe Silt Loam	85,275		127,674	212,949
Elko-Saha Soils	65,158		14,893	80,051
Mayook Silt Loam	10,414		1,280	11,694
Oldtown Very Fine Sandy Loam	2,829		255	3,084
Flagstone Sandy Loam	14,552		4,134	18,686
Kayook Silt Loam	3,525			3,525
Lakit Sandy Loam			2,478	2,478
Kokum Very Fine Sandy Loam	3,409			3,409
Michel Sandy Loam	4,815		37	4,852
Kinbasket-Flatbow Soils	18,922		24,144	43,066
Hosmer Clay Loam	6,312		203	6,515
Cedrus Clay	12,313		1,743	14,056
Hornickel Silt Loam	540			540
Abruzzi Clay	5,538		46	5,584
Cadorna Loam	1,011			1,011
Madias Silty Clay Loam	4,551		47	4,598
Nestor Silt Loam	2,620		77	2,697
Narboe Clay Loam	6,183		119	6,302
Sparwood Sandy Loam	857			857
Crahan Sandy Loam	4,607		534	5,141
Gokato Clay Loam	1,954		81	2,035
Wardrop Sandy Loam	846			846
Wigwam Soil Complex	20,621		6,187	26,808
Crowsnest Sandy Loam		9,674	3,402	13,076
Salishan Silt Loam		24,160	4,534	28,694
Muck		1,057		1,057
Rough Mountainous Land			280,896	280,896
Rock Outcrop			436	436
Bluffs and Ravines			30,369	30,369
Concentrator Dump			622	622
Placer Tailings			288	288
Swamp			2,566	2,566
Water			22,968	22,968
Totals	300,821	34,891	539,893	875,605

CLASSIFICATION OF SOILS ACCORDING TO THEIR SUITABILITY FOR IRRIGATION

A classification of soils according to suitability for irrigation was combined with the soil survey of the upper Kootenay and Elk River valleys. This work was done to show the quality of the land for irrigation and to estimate the water requirements of the several soil types.

The method of survey follows a procedure outlined by W. E. Bowser and H. C. Moss,† with such modification as became necessary in a mountainous

† W. E. Bowser, H. C. Moss, A Soil Rating and Classification for Irrigation Lands in Western Canada, Scientific Agriculture 30:165-171, April, 1950.

region. Departures from the above reference are included in the proceedings of the Department of Agriculture Reclamation Committee.* General definitions of the main irrigation soil groups are as follows:

Group 1 Soils

Deep, uniform, alluvial, glacio-lacustrine and glacial till soils of medium to medium heavy texture, including sandy loams, loams, silt loams, and silty clay loams. Topography is good and there are very few stones. These soils have desirable structure and other profile features, and none to very slight deductions for alkali, topography, etc. This group represents the most desirable irrigation soils, capable of producing all irrigation crops that can be grown for commercial purposes in any given climatic regime.

Group 2 Soils

Less uniform soils of the same types as in Group 1, including well-drained glacio-lacustrine clays; all Group 1 soils with moderate deductions for topography, stones, gravel, etc. Most of the Group 2 soils have similar crop adaptations to those of Group 1, but are rated down on account of being less uniform, requiring stone clearing or having some other limitation.

Group 3 Soils

Heavy clays with fair to good drainage. Group 1 and 2 soils with moderate to high deductions for stones, topography, drainage, etc. Gravelly river channels and terraces with a comparatively stone free solum. Group 3 soils have a more limited range of crop adaptation than the first two groups, or are more difficult to irrigate.

Group 4 Soils

Heavy clays with alkali subsoils and flat topography with slow or impeded drainage. All soils with depressional topography subject to flooding. Soils requiring drainage are classed in Group 4 until feasibility of drainage is determined. When drained such soils may be classed in a higher group. Thin, gravelly river terraces and channel bottoms. Soils having limited use. With detailed survey the poorer acreage of such soils may be assigned to Group 5.

Group 5 Soils

Stony, gravelly and shallow soils. Soils with rough topography and all other soils of very limited use that may be irrigated for rough pasture. Such soils may not be worthy of any development under present conditions, but may in time have limited use when land is at a premium.

The different classes of soils according to suitability for irrigation, and the acreage of each class, are shown in Table 5.

Combined soil and land class maps, showing the distribution of the several land classes, were produced. Hand-made copies of these maps were distributed to the Water Resources Division, Department of Northern Affairs and Natural Resources, Vancouver, B.C., and the Department of Agriculture, Victoria, B.C. These unpublished maps have value as a base for detailed surveys of irrigation proposals.

Water requirements of soils were estimated and made subject to future correction, by means of field and laboratory testing of soils and irrigation

* Proceedings of the Reclamation Committee, Brief 22, Department of Agriculture, Kelowna, B.C., May 28, 1953.

plot experiments. The estimated total water requirement of 300,821 acres of irrigation land in the Upper Kootenay and Elk River valleys amounts to about 796,917 acre-feet per annum.†

TABLE 5. CLASSIFICATION OF SOILS ACCORDING TO SUITABILITY FOR IRRIGATION

Irrigable Class	Acreage of Irrigable Soil Groups					Total
	1	2	3	4	5	
Plumbob Silt Loam	....	827	7,576	....	....	8,403
Saha Silt Loam	....	....	1,639	8,238	180	10,057
Hyak Sandy Loam	....	....	391	3,795	1,323	5,509
Wycliffe Silt Loam	....	20,309	64,627	339	....	85,275
Elko-Saha Soils	....	....	2,967	39,708	22,483	65,158
Mayook Silt Loam	....	6,097	4,242	75	....	10,414
*Oldtown V.F.S.L.	308	624	524	1,373	....	2,829
Flagstone Sandy Loam	....	9,911	3,955	686	....	14,552
Kayook Silt Loam	....	2,579	946	....	....	3,525
*Kokum V.F.S.L.	....	2,530	766	113	....	3,409
Michel Sandy Loam	....	1,450	1,442	1,923	....	4,815
Kinbasket-Flatbow Soils	....	3,890	15,032	....	....	18,922
Hosmer Clay Loam	....	....	4,308	2,004	....	6,312
Cedrus Clay	....	....	11,614	699	....	12,313
Hornickel Silt Loam	....	....	540	....	....	540
Abruzzi Clay	....	....	5,320	218	....	5,538
Cadorna Loam	....	644	169	198	....	1,011
Madias Silty Clay Loam	....	2,610	1,335	606	....	4,551
Nestor Silt Loam	....	....	1,293	886	441	2,620
Narboe Clay Loam	....	....	1,453	4,346	384	6,183
Sparwood Sandy Loam	....	....	552	305	....	857
Crahan Sandy Loam	....	....	120	4,487	....	4,607
Cokato Clay Loam	....	....	545	1,409	....	1,954
Wardrop Sandy Loam	....	....	801	45	....	846
Wigwam Soil Complex	203	15,127	2,615	2,510	166	20,621
Totals	511	66,598	134,772	73,963	24,977	300,821

* Very Fine Sandy Loam.

CHEMICAL CHARACTERISTICS

The limited analysis of several soil profiles is tabulated in Table 6. Since the analyses are of virgin soils, they show the difference of nitrogen content in the several horizons as between forest and grassland soils. In the forest soils the A_0 horizon has the highest content of nitrogen, followed by a sharp drop in the percentage of nitrogen in the mineral soil horizons. In the natural grassland soils, such as the Plumbob and Saha series, the nitrogen and organic matter content is greater and more uniformly distributed in the soil itself.

This information points to the marked deficiency of organic matter and nitrogen in forest soils when they are reclaimed. Such soils should receive substantial treatment with manure and fertilizer before the first crop is planted. On the other hand, the natural grassland soils will often produce crops without any fertilization for some years after reclamation, due to the residue of available minerals, organic matter, nitrogen and a desirable micro population in the soil itself. Advantage of this feature is taken to produce crops of wheat and other grains where summer moisture is sufficient.

The content of phosphorus in virgin soils is related to the total amount of this element in the parent material. In this regard the calcareous parent materials in the mapped area contain about 0·12 per cent P_2O_5 compared with

† Proceedings of the Reclamation Committee, Brief 26, Department of Agriculture, Kelowna, B.C. September, 1953.

about 0·24 per cent and 0·20 per cent for mapped soils in the Okanagan and Prince George areas. Since the mapped area is relatively undeveloped, a deficiency of available phosphorus has not been established. However, the low totals indicate that plot testing for phosphorus response in crops should be undertaken when desirable.

Since phosphorus is relatively insoluble it tends to concentrate in the A horizon. This is due to the action of plant roots over many generations. The roots transport phorphorus requirements of the plants from the lower part of the solum, and the phosphorus is used throughout the plant tissues. As the plants die and decay, the phosphorus is returned to the soil and deposited in the A horizon, where it becomes fixed. However, it is noteworthy that a marked concentration of phosphorus in horizon A has not occurred in the given examples. This is probably due to the slow growing and rather scanty vegetation in the dry parts of the mapped area.

The total content of potash in these soils compares favorably with soils of other mapped areas in British Columbia, where potash deficiency is not known. Okanagan valley soils vary from 1·50 to 4·00 per cent total potash, and the soils of the Prince George area have from 1·00 to 2·00 per cent K_2O. The examples shown in Table 6 have from 1·00 to 2·50 per cent K_2O.

The calcium carbonate content of the mapped soils is their outstanding feature in comparison with soils in other parts of British Columbia. In the Okanagan valley, the lime rich soils have a maximum of about 6·00 per cent of CaO in the B_{ca} horizon, whereas Upper Kootenay River valley soils may contain up to 30 per cent CaO in horizon B_{ca}.

Under the natural conditions the high lime content intensifies the effect of drought and stunts the native vegetation. It is remarkable, however, that when irrigation is applied the high lime content of the soil does not have an adverse effect on soil fertility. Of course, lime-induced chlorosis is common where the B_{ca} horizon has been exposed by grading or levelling of irrigated land, and the soil material thus exposed is definitely infertile. Exposure of horizon B_{ca} by grading or erosion should be avoided.

The total content of MgO and the exchangeable portion compares with similar totals in soils of the Okanagan and Prince George areas. Absence of epsom salt accumulations, and a comparatively high reaction in the lower part of the solum indicate that available magnesium and also sodium are in the form of carbonates.

The soil reaction (pH) shown in Table 6 gives some idea of the range that occurs from the surface to the parent material in the soil types analyzed. It is obvious that the high reaction at the top of the parent material is the reaction at the contact between the solum and the geological material beneath, and this reaction is higher than the parent material will average.

Under ordinary conditions a reaction of pH 9·0 indicates accumulation of sodium carbonate or black alkali as a result of lateral seepage that does not contain an appreciable quantity of sulphates. Usually the whole profile is contaminated by the rise of the water table and evaporation from the surface. The resulting soil is said to be strongly alkaline and of doubtful value for agriculture.

In this case, the accumulation of sodium carbonate is due to its formation in the upper horizons of the profile, from which it has moved downward.

TABLE 6. CHEMICAL ANALYSIS OF SOIL PROFILES**

Soil	Horizon	Depth	Gravel	Loss on* Ignition	H_2O	Inorganic CasCaCO$_3$	N	P_2O_5	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Exchangeable CaO	Exchangeable MgO	Exchangeable K_2O	Exchangeable Na_2O	pH
		(ins)	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Plumbob Silt Loam.....	A$_1$	0 - 7	16	6·54	2·08	....	0·23	0·18	......	....	....	......	......	......	......	0·235	0·030	0·040	0·002	7·0
	B$_1$	7 - 13	41	4·93	1·94	0·42	0·17	0·16	......	....	....	......	......	......	......	0·453	0·045	0·036	0·004	7·7
	Bca	13 - 17	60	3·82	1·06	20·58	0·14	0·15	......	....	....	......	......	......	......	0·291	0·019	0·015	0·002	8·2
	C	17 +	59	1·05	0·35	20·57	0·02	0·12	......	....	....	......	......	......	......	0·252	0·022	0·015	0·002	8·8
Saha Silt Loam.........	A$_1$	0 - 3½	26	10·24	2·82	....	0·39	0·18	......	....	....	......	......	......	......	....	....	....	....	6·6
	A$_3$	3½ - 7	61	7·28	3·22	....	0·19	0·16	......	....	....	......	......	......	......	....	....	....	....	6·7
	B—D	7 - 17	69	5·26	2·72	0·58	0·15	0·18	......	....	....	......	......	......	......	....	....	....	....	7·5
	Dca	17 - 28	94	2·95	0·88	40·90	0·07	0·15	......	....	....	......	......	......	......	....	....	....	....	8·4
Wycliffe Silt Loam......	A$_1$	0 - 2	....	17·26	3·89	....	0·51	0·10	......	....	....	......	......	......	......	0·767	0·051	0·072	0·002	7·0
	B	3 - 17	14	2·92	1·56	....	0·05	0·09	......	....	....	......	......	......	......	0·280	0·034	0·033	0·005	7·1
	Bca	17 - 36	33	3·01	1·22	20·66	0·07	0·23	......	....	....	......	......	......	......	0·392	0·043	0·031	0·013	8·7
	C	36 +	49	1·50	0·56	31·99	0·02	0·13	......	....	....	......	......	......	......	0·229	0·030	0·030	0·005	9·0
Elko Silt Loam.........	A$_1$	0 - 1	tr	22·96	6·39	....	0·58	0·17	......	....	....	......	......	......	......	....	....	....	....	6·8
	B	1 - 13	57	3·93	2·56	....	0·05	0·13	......	....	....	......	......	......	......	....	....	....	....	6·1
	B—D	13 - 27	75	1·24	0·52	12·57	0·01	0·11	......	....	....	......	......	......	......	....	....	....	....	8·4
Mayook Silt Loam......	A$_1$	0 - 1	....	32·90	6·60	....	0·78	0·12	41.44	7·24	1·20	3·30	1·11	1·02	0·68	1·843	0·193	0·064	....	7·0
	A$_2$	1 - 2½	....	4·00	1·79	....	0·11	0·06	69·09	12·91	4·56	1·33	1·61	2·21	1·15	0·492	0·065	0·033	....	7·4
	B$_2$	2½ - 7	....	2·06	1·34	....	0·10	0·08	71·04	13·66	3·88	1·05	1·68	2·22	1·18	0·342	0·034	0·039	....	7·6
	B$_3$ca	7 - 11	....	2·52	0·92	32·0	0·10	0·20	49·00	9·12	2·85	15.43	3·23	1·45	0·78	0·403	0·021	0·015	....	8·5
	B$_4$ca	11 - 17	....	2·11	0·81	36·5	0·11	0·18	42·12	7·89	3·17	20·00	3·45	1·48	0·57	0·389	0·019	0·012	....	8·8
	C	17 +	....	0·88	0·26	32·5	0·04	0·11	48·71	9·65	3·98	13·66	4·06	1·81	0·62	0·262	0·046	0·017	....	9·3

* Determined by igniting the 100 mesh material at 450°C for 3 hours.
** Analysis by Chemistry Division, Science Service, Canada Department of Agriculture, Ottawa.

TABLE 6. CHEMICAL ANALYSIS OF SOIL PROFILES**—*Conc.*

Soil	Horizon	Depth	Gravel	Loss on* Ignition	H_2O	Inorganic $CaCO_3$	N	P_2O_5	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Exchangeable CaO	Exchangeable MgO	Exchangeable K_2O	Exchangeable Na_2O	pH
		(ins)	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Oldtown Very Fine Sandy Loam..........	A_2	0 - 1	....	2·79	1·62	....	0·14	0·08	75·88	9·82	2·80	1·07	1·31	1·80	1·07	0·304	0·067	0·080	....	7·0
	A_3	1 - 4	....	1·23	0·66	....	0·06	0·11	73·05	13·24	3·88	0·99	1·78	2·48	1·30	0·124	0·032	0·022	....	7·6
	B_2	4 - 16	....	1·41	0·88	....	0·06	0·11	72.56	13·24	3·17	1·09	1·74	2·25	1·30	0·174	0·033	0·015	....	7·2
	B_3	16 - 22	....	1·02	0·48	1·4	0·06	0·15	73·40	12·11	4·47	1·49	1·90	2·29	1·37	0·240	0·022	0·006	....	8·3
	Cca	22 +	....	0·88	0·22	8·4	0·06	0·14	70·72	10·13	3·91	4·87	2·20	1·72	1·30	0·284	0·030	0·016	....	8·9
Flagstone Sandy Loam..	A_1	0 - 3	tr	3·23	1·10	....	0·07	0·08	......	....	....	......	......	......	......	0·168	0·014	0·017	0·002	7·2
	B_3ca	3 - 17	tr	2·38	0·96	11·25	0·07	0·13	......	....	....	......	......	......	......	0·347	0·040	0·015	0·002	8·6
	B_4ca	17 - 36	0	0·78	0·22	26·32	0·02	0·12	......	....	....	......	......	......	......	0·235	0·029	0·007	0·001	8·9
	C	36 +	tr	0·70	0·16	26·16	0·02	0·10	......	....	....	......	......	......	......	0·235	0·028	0·006	0·001	9·0
Kokum Very Fine Sandy Loam..........	A_2	0 - 2	....	1·40	0·34	2·1	0·08	......	......	....	....	......	......	......	......	0·136	0·016	0·015	....	7·8
	B	2 - 12	....	1·04	0·27	4·6	0·06	......	......	....	....	......	......	......	......	0·216	0·015	0·010	....	8·3
	C	12 +	....	1·92	0·50	1·6	0·08	......	......	....	....	......	......	......	......	0·201	0·018	0·015	....	8·0
Salishan Silt Loam......	....	2 - 5	....	7·60	2·20	9·6	0·34	......	......	....	....	......	......	......	......	0·495	0·115	0·022	....	8·4
	....	5 +	....	3·22	1·56	18·3	0·16	......	......	....	....	......	......	......	......	0·300	0·162	0·011	....	8·9
Silt Loam from the Wigwam Complex.....	A_1	1 - 2½	0	36·82	8·44	....	0·98	0·13	......	....	....	......	......	......	......	1·366	0·163	0·094	0·002	6·4
	A_3	2½ - 9	0	1·16	0·70	....	0·03	0·05	......	....	....	......	......	......	......	0·100	0·009	0·007	0·001	6·0
	B_1	9 - 17	0	2·14	1·29	....	0·04	0·13	......	....	....	......	......	......	......	0·140	0·027	0·028	0·002	6·1
	B_2	17 - 27	tr	1·88	2·02	....	0·03	0·07	......	....	....	......	......	......	......	0·200	0·026	0·023	0·006	6·7
	C	27 +	tr	2·18	1·00	....	0·02	0·08	......	....	....	......	......	......	......	0·146	0·022	0·014	0·004	7·1

* Determined by igniting the 100 mesh material at 450°C for 3 hours.

Unable to escape and form accumulations of alkali by down-slope seepage, it has remained in place. This is the result of a dry climate, where the profile is not sufficiently wetted at any time of the year to leach soluble salts away. Under these conditions a pH of 9·0 or more in the lower part of the profile is not harmful to the soil above, provided the soil is not eroded and the lower horizons exposed.

However, there may be sufficient black alkali in the B_{ca} horizon to move and contaminate any seepages that occur as a result of irrigation. It may be necessary, therefore, to give prompt attention by means of underdrainage to seepages that appear after irrigation works are established.

TABLE 1—APPENDIX

Average Monthly and Annual Temperatures for the Period Shown*
(Degrees F.)

Station	Elevation	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	Years of record
Newgate	2,800	18	25	35	45	53	59	66	63	54	44	31	23	43	1918–54
Fernie	3,305	17	20	30	41	50	56	62	60	51	42	29	20	40	1916–54
Cranbrook	3,013	16	21	32	43	51	58	63	62	52	42	29	20	41	1916–54
Kimberley Concentrator	3,500	18	23	30	41	50	57	68	61	54	45	27	23	41	1942–49
Kimberley Airport	3,016	13	22	29	43	52	58	64	62	54	42	28	19	40	1943–54

*Climate of British Columbia, Department of Agriculture, Victoria, B.C.

TABLE 2—APPENDIX

The Frost Free Period*

—	Fernie	Michel	Morrissey	Newgate	Flagstone	Baynes Lake	Ft. Steele	Cranbrook	Cranbrook Airport	Kimberley Airport
Elevation (feet)	3,305	3,800	3,138	2,800	2,366	2,800	2,433	3,014	3,013	3,003
Years on Record	33	4	1	32	20	7	4	33	9	4
Average Last Spring Frost	June 1	June 19	....	June 3	May 19	June 10	June 18	June 10	June 4	May 30
Earliest Last Spring Frost	May 4	June 4	....	May 4	April 22	May 29	June 11	May 17	May 19	May 10
Latest Last Spring Frost	July 12	July 4	June 27	July 4	June 25	June 27	June 24	July 7	July 12	June 13
Average First Fall Frost	Sept. 7	Aug. 19	....	Sept. 4	Sept. 14	Sept. 10	Sept. 8	Aug. 27	Sept. 10	Sept. 15
Earliest First Fall Frost	July 19	Aug. 4	July 23	July 27	Aug. 22	Sept. 1	Aug. 28	July 19	Aug. 20	Sept. 2
Latest First Fall Frost	Oct. 7	Aug. 29	....	Oct. 13	Oct. 8	Sept. 21	Sept. 16	Sept. 20	Oct. 8	Sept. 19
Average Frost Free Period	98 days	60 days	....	93 days	118 days	92 days	82 days	77 days	98 days	108 days

* The Frost-Free Season in British Columbia, Meteorological Division, Department of Transport, 1949.

TABLE 3—APPENDIX

Average Monthly and Annual Days with Measurable Precipitation at Cranbrook*
(7 years)

—	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Days with rain	1	1	3	7	10	9	8	6	7	8	4	5	69
Days with snow	9	8	5	1	....	....	....	....	....	1	6	11	41
Days with Precipitation	10	9	7	7	10	9	8	6	7	9	9	15	106

*Cranbrook Airport, Department of Transport.

TABLE 4—APPENDIX

Average Monthly and Annual Precipitation for the Period Shown*
(Inches)

Station	Elevation (feet)	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Years of record
Newgate	2,800	1·44	1·08	0·97	0·76	1·21	1·64	0·88	0·86	0·89	1·12	1·28	1·68	13·81	1918–54
Elko	3,000	2·36	1·20	1·31	1·26	1·62	2·73	1·43	1·33	1·56	1·82	1·53	1·95	20·10	1924–54
Fernie	3,305	4·84	3·77	3·39	2·37	2·60	2·90	1·56	1·60	2·56	4·11	4·24	5·66	39·60	1916–54
Cranbrook	3,013	1·48	1·14	0·85	0·68	1·24	1·92	1·09	1·02	1·11	1·03	1·34	1·67	14·57	1916–54
Kimberley Airport	3,016	1·45	1·11	1·08	0·81	1·25	2·17	0·68	1·37	0·94	1·54	1·19	1·85	15·44	1943–54
Wasa	2,300	1·34	1·06	0·80	0·68	1·33	1·87	0·81	1·07	1·13	1·33	1·21	1·73	14·36	1924–54
Canal Flats	2,653	1·52	1·28	1·04	0·84	1·52	2·16	1·24	1·27	1·25	1·13	1·45	1·61	16·31	1924–49

* Climate of British Columbia, Department of Agriculture, Victoria, B.C.

TABLE 5—APPENDIX

Average Values of Relative Humidity at Four Fixed Hours*
Cranbrook Airport, May, 1940, to April, 1946

Pacific standard time	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
4.30 A. M.	96	94	89	89	89	89	87	85	90	93	94	95
10.30 A. M.	89	78	62	54	51	52	44	44	56	68	83	90
4.30 P. M.	87	71	55	46	44	46	38	36	48	62	83	89
10.30 P. M.	94	92	81	80	74	76	69	69	81	88	93	93
Monthly Average	91	84	72	67	64	66	59	58	69	78	88	92

*Cranbrook Airport, Department of Transport.

GLOSSARY

Certain terms have been used in this report to describe features in the mapped area. Definitions of the more or less uncommon terms are as follows:

Acre foot—The amount of irrigation water required to cover an acre of land to a depth of one foot.

Aggregate (soil)—A single mass or cluster of soil consisting of many soil particles held together in the form of a prism, granule or crumb, etc.

Anaerobic humification—Decomposition of organic matter in waterlogged situations.

Alluvial fan—A fan-shaped outwash deposit formed at the toe of a mountain slope where a tributary valley enters the main valley.

Available nutrients—Plant nutrients in soluble form; readily available for absorption by plant roots.

Azonal soil—Any group of soils without well-developed profile characteristics, owing to their youth or conditions of parent material or relief.

Base exchange capacity—A measure of the absorptive capacity of the soil for cations (hydrogen plus bases) or the amount of cations which can be absorbed by a given amount of soil, expressed in terms of milli-equivalents per 100 grams of soil. A soil with a fairly high exchange capacity is preferred to one with a low exchange capacity because it will retain more plant nutrients and be less subject to leaching or exhaustion.

Calcareous material—Material containing a relatively high percentage of calcium carbonate; it visibly effervesces when treated with hydrochloric acid.

Cleavage—The capacity of a soil on shrinkage to separate along certain planes more readily than others.

Consistence (soil)—The relative mutual attraction of the particles in the whole soil mass, or their resistance to separation or deformation. Consistence is described by such general terms as loose or open; slightly, moderately or very compact; mellow; friable; crumbly, plastic; sticky; soft; firm; hard and cemented.

Colluvial material—Heterogeneous deposits of rock fragments and soil material accumulated at the base of comparatively steep slopes through the influence of gravity, including creep and local wash.

Drift—Material of any sort deposited in one place by natural forces. Glacial drift includes all glacial deposits, whether stratified or unstratified.

Drumlin—A narrow, often spoon-shaped hill formed as part of a ground moraine. There is usually an abrupt slope at the end facing the ice movement and a gentle slope in the direction taken by the glacier.

Dune—A mound or ridge of loose sand piled by the wind.

Erosion—The wearing away of the land surface by running water, wind or other forces, including human activities.

Excessively drained—Soil that dries quickly, due to coarse texture or a porous substratum.

First bottom—A low-lying river deposit with vegetative cover, but subject to annual inundation.

Floodplain—River deposits generally formed where the grade is almost flat. The floodplain is characterized by a low levee along the river channel and a gentle slope to a swamped inner margin, the lowest elevation being along the side of the river valley.

Friable—Easily crushed between thumb and forefinger.

Glacio-lacustrine deposits—Sediments deposited in temporary glacial lakes.

Gley—A soil in which the material has been modified by saturation with water for long periods in the presence of organic matter.

Groundwater—Water that normally occurs below the surface of the ground.

Horizon—A horizontal layer in the soil profile having characters derived from the soil building process.

Humus—The well-decomposed, more or less stable part of the soil organic matter.

Interglacial—An epoch having climatic moderation between two successive glacial episodes.

Irrigation land—A term used to include both irrigated and potentially irrigable land.

Kame—The deposit of a stream that flowed between a glacier and a valley side. After retreat of the ice, the kame remains as a terrace-like deposit.

Kettle—A depression formed in outwash by collapse of the surface after the melting of buried ice. Kettles vary in size. Some are dry; others contain ponds, swamps or bogs.

Lacustrine materials—Sediments deposited in lakes.

Leaching—The removal of soluble constituents from the soil by percolating water.

Levee—Natural embankments along river channels in floodplain areas.

Loess—Sand, silt and clay material moved and deposited by wind.

Marl—Calcium carbonate precipitated from solution at the mouths of springs and in seepage areas.

Mature soil—A soil with well-developed profile characters that were produced by the natural processes of soil formation. The mature soil is in equilibrium with its environment, hence it is unlikely to develop further unless there is a change of climate.

Melt water—Water formed by the melting of ice or snow.

Mottled—Irregularly marked with spots of different colors. Mottling of soils usually indicates poor aeration and lack of good drainage.

Moraine—(*a*) *Lateral moraines*—Drift ridges formed along the lateral margins of valley glaciers from material plucked from the valley sides.

(*b*) *Gound moraines*—Drift accumulated on the sole of the glacier, that may form a rolling or drumlinized plain in mountain valleys. The drift consists chiefly of till and sands and gravels weathered from till.

(*c*) *Terminal or end moraines*—Ridge-like accumulations of drift found at the terminal margin of a glacier.

Muck—Dark colored organic material accumulated in damp areas. There is relatively high mineral content and the bulk of the plant remains are decomposed beyond recognition.

Parent Material—Geological material from which a soil is derived.

Peat—Undecomposed to partly decomposed organic material with recognizable plant remains. Peat is accumulated in bogs and seepage areas under moist conditions.

Permeability—The quality or state of a soil or any horizon in the profile that enables it to transmit water or air to all parts of the mass.

Percolation—The downward movement of water through the soil, especially the downward flow of water in saturated or nearly saturated soil.

pH—A notation used to designate the relative acidity or alkalinity of soils or other materials. A pH of 7·0 indicates the neutral condition. Higher values indicate alkalinity and lower ones acidity.

Plant nutrients—The elements taken in by the plant, essential to its growth and used by it in the elaboration of its food and tissue. These include nitrogen, phosphorous, potassium, calcium, magnesium, sulphur, iron, manganese, copper, boron and perhaps others obtained from the soil; and carbon, hydrogen and oxygen obtained chiefly from air and water.

Plastic—Capable of being molded or modeled without rupture when moist.

Podzolization—A general term referring to the process by which soils are depleted of bases, become acid and develop leached A horizons. Specifically, the term refers to the process by which podzol soils are formed and in which iron and alumina are removed from the upper part of the soil profile more rapidly than silica. This results in the development of a light colored surface horizon and an accumulation of iron, alumina and organic matter in the B horizon.

Porosity—The degree to which the soil mass is permeated with pores or cavaties. It is expressed as the percentage of the whole volume of the soil which is occupied by voids. The total porosity includes both capillary and non-capillary porosity. The capillary porosity refers to the small pores that hold water by capillarity, while the non-capillary porosity refers to the larger pores that will not hold water by capillarity. A soil with low noncapillary porosity may be called a "non-porous" or "dense" soil, while a soil with high noncapillary porosity may be called "porous" or "open".

Relief—The elevations or inequalities of the land surface when considered collectively. Minor surface configurations are referred to as micro-relief.

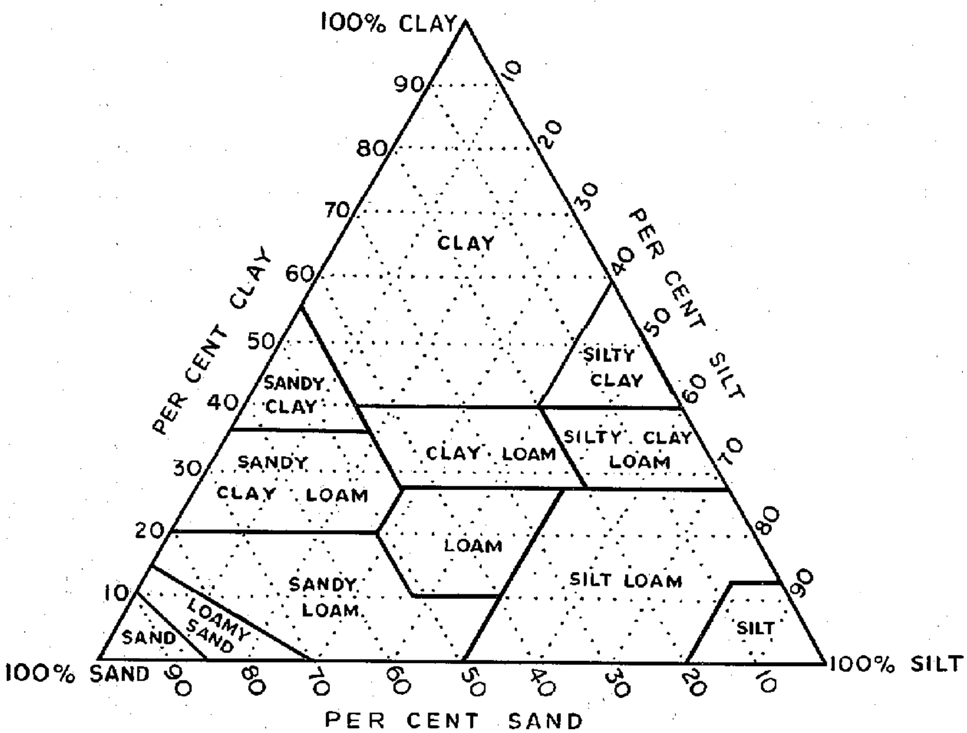
Second bottom—The river terrace just above the level of annual inundation, but still subject to flooding in years of exceptionally high water.

Seepage—Saturation of the soil by movement of groundwater to the surface, generally at the toe of the slope.

Soil Groups—Soil groups have distinctive soil characteristics that reflect the influence of environment. In the surveyed area these groups consist of Dark Brown, Brown Wooded, Gray Wooded, Podzolized Gray Wooded, Brown Podzolic and Groundwater soils.

Soil Profile—A vertical section of the soil. It extends through the A and B horizons to include a representative section of the C horizon or parent material.

CHART SHOWING PROPORTIONS OF SOIL SEPARATES IN VARIOUS SOIL TEXTURAL CLASSES



(From U.S. Department of Agriculture, Bureau of Plant Industry, Soils and Agricultural Engineering Guide for Textural Classification—March, 1948)

Soil separates—The particle sizes on which textural classes of soil are based. These are as follows:

	Diameter in Millimeters
Very Coarse sand	2·0 – 1·0
Coarse sand	1·0 – 0·5
Medium sand	0·5 – 0·25
Fine sand	0·25 – 0·10
Very Fine sand	0·10 – 0·05
Silt	0·05 – 0·002
Clay	Below 0·002

A further separation of sands is made according to the prevalence of different sized sand fractions. Medium and coarse sands may contain over 25 per cent coarse sand but not over 50 per cent fine sands. Fine and very fine sands must contain over 50 per cent of the respective fine sand fractions.

Soil structure—The morphological aggregates in which the individual soil particles are arranged. The following types are mentioned in this report:

Blocky—Block-like aggregates with sharp, angular corners.

Crumb—Porous granular aggregates.

Granular—More or less rounded soil aggregates with an absence of smooth faces and edges, relatively non-porous.

Massive—Large cohesive masses of soil, almost amorphous or structureless, with irregular cleavage faces.

Single grained—Each grain by itself, as in sand.

Subangular blocky—Mixed rounded and flattened faces with many rounded vertices.

Solum—The weathered part of the soil, in which the processes of soil formation are taking place. The A and B horizons.

Stratified—Composed of or arranged in strata or layers. The term is applied to geological materials.

Stream braiding—In shallow water a stream loaded with fine sediments may choke its channel with deposits, then overflow and cut new channels. This process is called braiding.

Talus—Fragments of rock and soil material collected at the foot of cliffs or steep slopes, chiefly as a result of gravitational forces.

Terrace—A flat, undulating or gently sloping plain of variable size bordering a river or lake. Many streams have a series of terraces at different levels, indicating floodplains at several stages of down-cutting of the stream valley.

Texture—Soil texture is based on the percentage of sand, silt and clay that a soil may have.

Till—An unsorted mixture of stones, sand, silt and clay transported by glaciers and deposited during the melting and recession of the ice front.

Till-plain—A land surface covered by glacial till, including some sorted material. The topography of the till-plain is variable.

Varve—Annual layers of a sediment generally found in glacial lake deposits. Varves consist of two thin layers of differing composition, one of which is laid down in summer and the other is deposited in winter, when the lake is frozen over. The winter layer is thinner, darker colored and of finer texture than the summer layer.

Water table—The upper limit of the soil or underlying material wholly saturated with water.

Weathering—The physical and chemical disintegration and decomposition of rocks and minerals.

Well-drained—The moisture relationship of soils of medium to heavy texture that are situated well above the level of streams and lakes. Such soils are moisture retentive, but any free or excess water can drain into the subsoil or down slope.

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