SOILS OF THE DOUKHOBOR (FORMER CCUB) LANDS OF BRITISH COLUMBIA

by

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Soils of the Doukhobor (Former CCUB) Lands of British Columbia

Abstract

The soils of the Doukhobor lands of British Columbia were studied as a part of a research project undertaken by faculty members of the University of British Columbia at the request of the Attorney General of the Province.

These lands comprise about 18,872 acres that occur in 16 parcels or communities in two general areas, 5327 acres near Grand Forks and 13,545 acres in the West Kootenay area. Soil surveys of these areas were conducted during the summers of 1951 and 1952. They were traversed by automobile and on foot and the soil type boundaries and related information plotted on aerial photographs of the scale of about one mile to 13 inches. From these photographs, soil maps were prepared of the scale of 400 feet to the inch.

In the course of the field operations bulk and undisturbed soil profile samples were collected from the more important soil types and tests were conducted relative to infiltration rates and field moisture capacities. The soil profile samples were used in the

laboratory during the winters for the determination of soil reaction, organic carbon, nitrogen, mechanical composition, apparent specific gravity, pore size distribution, permanent wilting percentage and other properties.

The more important soils of the valleys at Grand Forks were found to belong to the Black soil group while those in the West Kootenay were classed as Brown Podzolic. Small areas of Glei soils were also found. The soil parent materials were chiefly alluvium, glacial till and till derivatives and alluvial fan. From this information soil series were tentatively named and described.

The Black soils have reactions ranging from about pH 7 in the A_1 horizon to pH 8.5 in the C horizon where free lime occured. In reaction the Brown Podzolic soils were acid in all horizons and free lime was characteristically absent. The organic carbon content of the Black soils was significantly higher and the carbon to nitrogen ratio narrower than that of the Brown Podzolic soils.

The mechanical analysis showed the soils to be low in clay and silt and high in sand in both areas, the exceptions being the soils derived from fine textured alluvium such as the Shoreacres, Claybrick and Claypit series. High macro-pore space, infiltration rates and hydraulic conductivities also characterize most of the soils. The field moisture storage capacity and permanent wilting percentage values showed that most of the soils have very low available moisture storage capacities which seriously limit their use for crop production without irrigation.

When the soils were classified on the basis of their suitability for crop production without irrigation, only 3,037 acres or 17 percent of the area was classed as arable, and of this only 321 acres or 2 percent was Class 1. The land classed as nonarable without irrigation is suitable for forestry, wildlife, water storage, building sites and other uses. When rated on the basis of its suitability for crop production with sprinkler type irrigation 11,053 acres or 58 percent of the total area was classified as suitable for irrigation but of this only 635 acres or 3 percent was rated as Class 1. It is evident that irrigation will be a very important consideration in the use of these lands.

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The tolerance shown by the Doukhobors themselves while the fields and yards were being traversed and examined is gratefully acknowledged.

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INTRODUCTION

The forty year old problem of the Doukhobors adjustment to life in British Columbia reached such a point in the spring of 1950 that the Hon. G.S. Wismer, Attorney General of the Province of British Columbia, requested Dr. N.A.M. MacKenzie, President of the University of British Columbia to appoint a group which would carry out research aimed at a better understanding of the situation and make recommendations for its improvement.

Dr. H.B. Hawthorn of the University was appointed director of the research project, and work was started in the late summer of 1950. Dr. C.A. Rowles, also of the University of British Columbia was asked the following spring to begin a study of the characteristics of the lands occupied by the Doukhobors with a view to enabling them to be used more effectively in the future. The author was engaged to assist with this study which was conducted in cooperation with Mr. N.T. Drewry of the Department of Lands and Forests.

Field studies were conducted during the summers of 1951 and 1952 and laboratory investigations were made at the University the following winters. The work conducted during these periods forms the basis for this thesis.

DOUKHOBORS OF BRITISH COLUMBIA

The present study of the soils of the Doukhobor lands was but a small part of a much larger study of the Doukhobors of British Columbia (52). It is not possible to consider the soils and their use without some reference to their history and the present occupants. Therefore, a short reference to the Doukhobors and their use of the soils is desirable.

Hawthorn (52) 1952 in an excellent review of the contemporary picture reports, in part, as follows

> The Doukhobors emerged in Russia as a sect of dissident peasants separating themselves during the eighteenth century from the Orthodox Church. Throughout the nineteenth century their actions and beliefs led to intermittent conflict with state and clerical authorities and to persecution and exile, until humanitarians in England and Russia sought a land to which they could emigrate.
>
> In brief, their beliefs centered on direct revelation and guidance, which denied the need for a church organization and by extension included a denial of governmental authority and of the right of anyone to use

force in human affairs. The attempt to construct complete and logical systems of belief took them even farther, and the translation of belief into action was pursued without the compromises which are usually labelled "common sense". In order to protect their existence, however, they developed ways to evade, mislead and passively resist the inquiries and requirements of the authorities.

Welcomed by a government which wanted settlers, the first groups of Doukhobors arrived in Canada in 1899, some 7,427 in number. They were followed from 1900 to 1920 by smaller numbers of liberated exiles and their families, totalling 417 in all. In 1927 one small additional group arrived with Peter Petrovich Verigin, son of the man who had been the Doukhobor's first leader in Canada.

They were seeking land and freedom, on their own terms. In their negotiations they were represented by Aylmer Maude, one of the English Society of Friends, two Doukhobor delegates, and others. The Doukhobor understanding of the terms of entry and settlement almost certainly lacked clarity. They had in the first place fixed ideas of their goal which included freedom from the control of any government, and they failed to consider its impossibility. Decisions and communication were hopelessly bogged down, until they had to be made by Maude and the other representatives without the group's full understanding simply because full understanding could not be achieved. Something of the nature of their own governmental processes was shown by the fact that none of the representatives was properly invested with power to negotiate for them. Possibly, aware of the difficulties in the way of reaching and abiding by such agreements, some Doukhobors saw an advantage in being represented by negotiators whose bargains could be repudiated.

Conflict and more misunderstanding arising from this early confusion continue today. Yet they were at the outset surmounted to the extent that Doukhobor settlement as homesteaders took place on three blocks of land in Saskatchewan, then Northwest Territories. There, in accordance with their beliefs, they tried variations of communal life, some villages operating as separate cooperative units, and some groups of villages operating with a central administration. In sharp contrast, from the beginning, an ever-increasing number of farmers worked their land as individuals and set their sights at individual ownership, feeling there was no essential conflict between Doukhoborism and life in Canada.

In 1908 a pioneer group left to start the development of land they had purchased in British Columbia. Within the next five years they were followed by nearly six thousand others. Their reasons for the westward move were not entirely unlike those of some other pioneers; they wished to escape from what they felt to be the constraints of government and the corrupting influences of their Canadian neighbours. Purchasing the land in place of homesteading obviated the need to take an oath of allegiance. The move was precipitated by the stated intention of the Saskatchewan government to open schools throughout the settlements.

The westward movement of Doukhobors continued through the twenties and thirties, its most recent push the foundation of the small colony at Hilliers on Vancouver Island. There was one major eastward flow to form a settlement in Alberta in 1924. The present urge for migration or relocation is in part similar to the restlessness of earlier decades which impelled the westward drives; some of the recent proposals for relocation are directed northward because a western frontier no longer exists.

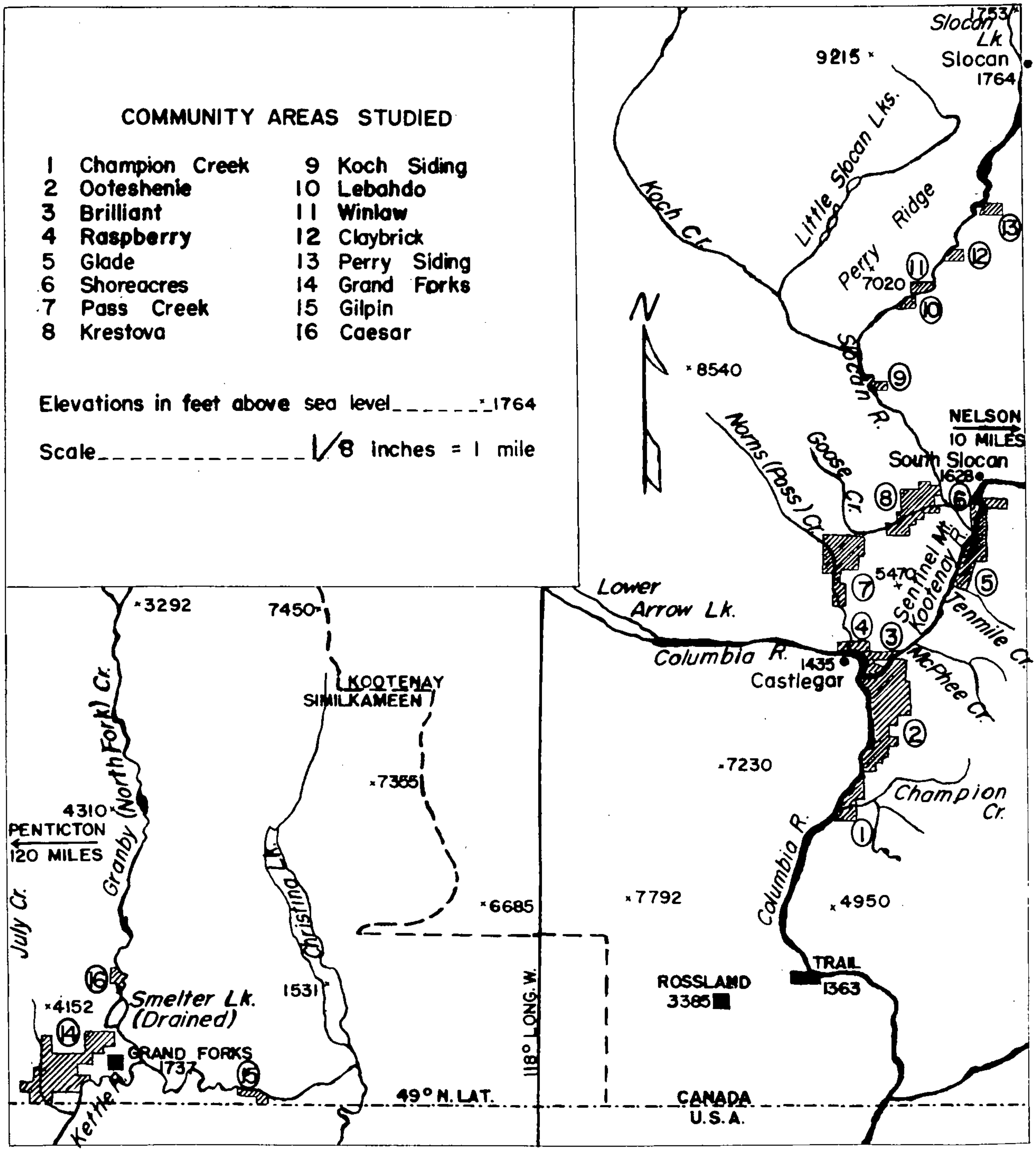
From Hawthorn's review, it is apparent that the so called Doukhobor problem in British Columbia, began with the purchase of the land now under study and ever since this land has played an important part in the troubled history of the Doukhobors.

DOUKHOBOR LANDS OF BRITISH COLUMBIA

The Doukhobor lands of British Columbia lie in the south eastern section of the province and their actual locations are shown on the sketch map of Figure 1. The individual blocks of land are located in the Grand Forks and West Kootenay areas and in this study they are referred to as the Doukhobor lands. These lands were owned by the Doukhobor company, The Christian Community of Universal Brotherhood (CCUB), until its bankruptcy in 1937 at which time the Provincial Government acquired trusteeship of the lands.

Zubek (59) 1952 reports that upon arrival in British Columbia in 1909 the Doukhobors found much of their land heavily forested so they immediately started clearing before building homes. Jamieson (52) 1952 records that by 1910 some 8,800 acres of land had been purchased in the West Kootenay and Grand Forks areas and that sawmills, roads, bridges and irrigation systems had been built. Thousands of fruit trees had also been planted. By

FIGURE I



Sketch map showing location of former Christian Community of Universal Brotherhood lands studied in the Kootenay and Similkameen Land Districts of British Columbia and indicating some major physiographic features.

the beginning of World War I the acreage of land purchased by the Christian Community of Universal Brotherhood had risen to 14,403 acres (52).

Trevor (49) 1931 made a detailed study of the agriculture of the Doukhobor lands and reported the acreages included in Table 1 below. Also included in this table are the acreages supplied by the Department of Lands and Forests, Victoria, B.C. (18) 1953.

TABLE 1

AREA OF DOUKHOBOR LANDS IN BRITISH COLUMBIA, 1931 AND 1951

	1931[1] (acres)	1951[2] (acres)	Reduction (acres)
Grand Forks	5,899	5,327	572
West Kootenay	16,157	13,545	2,612
TOTAL	22,056	18,872	3,184

1 Figures from Trevor (49) 1931
2 Figures from Report of Dept. of Lands and Forests (18) 1953

It will be noted from Table 1 that the acreage of land decreased between 1931 and 1951. This reduction of approximately 3,184 acres may be accounted for by the land sales over the 20 year period which occured concurrently with the general decline of CCUB activities during this period.

Earlier writers, (22) (32) (44), gave very glowing reports of the Doukhobors' agricultural development, Maude (32) 1904 lauds the "prosperous" community farms and the "progressive" inhabitants. Hindus (22) 1922-23, as cited by Trevor, accounts as follows:

> . . . one gazes down upon endless rows of orchards and gardens, superbly cultivated. It has the aspect of a modern, progressive, prosperous community whose inhabitants are quick to make use of the discoveries of science, and spare no pains to woo the precious crop from a stubborn soil.

Despite these praiseworthy accounts Trevor (49) 1931 could find no facts to support them. He observed that the orchards were well planted only in the sense that the rows were straight but otherwise the fields presented ". . . a miserable and pitiful sight of ill-cultivated and clumsily plotted agricultural crops and orchards." Even at that time many of the apple varieties were obsolete. A good deal of the apple crop was of very poor quality having been adversely affected by pests and diseases.

TABLE 2

UTILIZATION OF [redacted] DOUKHOBOR LANDS OF BRITISH COLUMBIA[1] (1951)

	Cultivated (Including Former Orchard) Irrigated	Non-Irrigated	Pasture (Formerly Cultivated or Orchard)	Pasture (Rough)	Buildings	Forest and Wild Land	Community Totals
Grand Forks	130	685	930	1550	100	1321	4716
Gilpin	25		45			366	436
Caesar		20	25			130	175
TOTAL GRAND FORKS AREA	155	705	1000	1550	100	1817	5327
Champion Creek	34	69	188		4	625	920
Ooteshenie	75	185	1275	230	30	2205	4000
Brilliant	30	20	100	75	11	541	777
Raspberry	58	14	89		3	78	242
Glade	81	237	97	183	15	350	963
Shoreacres	7	210	40	45	6	323	631
Pass Creek	31	211	199	64	14	2071	2590
Krestova	40	210	390	50	45	1350	2085
Koch Siding	5	25	16	40	4	102	192
Lebahdo		18	5	145	1	145	314
Winlaw	3	64	33	23	4	96	223
Claybrick	1	50	100	16	7	170	344
Perry Siding	13	61	53	11	5	121	264
TOTAL WEST KOOTENAY AREA	378	1374	2585	882	149	8177	13545
TOTAL	533	2079	3585	2432	249	9994	18872

[1] Revised from Rowles (52) 1952 and Drewry (18) 1953

These same orchards were observed in 1951 and were reported to have no commercial value except for one at Raspberry Community (18). The actual use being made of the lands at this time is summarized in Table 2.

It will be noted from this table that of the total area, 18,872 acres, only 2,612 acres were classed as cultivated, and of this only 533 acres were irrigated. The largest area was in forest and wild land, 9,994 acres, and as such was of very limited value. In all, some 85 percent of the total area was used for rough pasture or forest trees and received no cultural attention whatsoever.

Thus it seems that by 1931 abandonment of the lands had already begun and continued up to the present. Rowles (52) 1952 gives the following summary.

> From these considerations it seems that the change in the condition of the agriculture on the CCUB lands since they went into receivership is not as great as the present appearance of the land might indicate. What essentially has taken place is that the orchards and fields that were bringing little cash return to the villages have been turned over to grass and used for hay and pasture. The villages did and still do have fine gardens produced by hand on small plots. However, apart from these small intensively cultivated gardens, the land was not and is not being utilized effectively. Many factors would be involved in an attempt to improve this situation . . .

Jamieson (52) 1952 reports on the history of the economic decline of the Doukhobor organization, as follows.

> The CCUB began to decline rapidly after the death of Peter Vasilivich Verigin and the accession of his son, Peter Petrovich Verigin, to leadership. During the interim the executive board of the CCUB, in order to consolidate the Company's accounts, borrowed $350,000 from the Bank of Commerce, secured by bonds held by the National Trust Company. After Peter Petrovich Verigin assumed office as President of the CCUB, it went further into debt, and finally into complete bankruptcy in 1937.
>
> There have been many reasons offered to explain this catastrophic reversal in the fortunes of the Doukhobors' major communal undertaking. Much has been spoken and written about Peter Petrovich Verigin's spectacular mismanagement and alleged misappropriation of hundreds of thousands of dollars of CCUB funds. This could not have been however, the sole or even the major cause of the CCUB's failure.......
>
> . . . . Growing numbers of Independents, whose main careers lay outside the CCUB, found the restrictions of community life irksome. They ceased to contribute to communal undertakings, moved out of the villages and established separated residences on their own farms or in nearby cities and towns. Included among them were some of the ablest members of the Doukhobor community -- one skilled administrator, for instance, who had managed the Community's lumbering operations and who left to build up a prosperous lumber business of his own.......
>
> . . . . At the other extreme, the Sons of Freedom were winning converts and growing in numbers and influence. They became increasingly hostile towards the CCUB leadership during the 1920's and 1930's, and helped to undermine the morale of the whole organization. Their growth was fostered by discouragement over the financial setbacks of the CCUB after years of frugality and effort on the part of the members, and by rising opposition to continued payments of principal and interest at high rates on loans from

banks and mortgage companies.......

> . . . . The whole burden of carrying on the CCUB, and particularly its large overhead of fixed annual payments of principal and interest on its debts, thus fell upon a shrinking membership. At the height of its operations the organization had had close to 8,000 members. By 1928 the number had fallen to 5,485. Ten years later there were only 3,103, of whom scarcely more than 2,000 were fully paid-up members. This trend forced higher individual assessments on each remaining member as time went on. The industrial undertakings of the CCUB were operating at a loss from 1928 on, and the Saskatchewan branches fell behind in their assessments. Depression and unemployment during the 1930's reduced the outside incomes and at the same time placed additional burdens on the Community for relief and social welfare on behalf of its destitute members. Finally, in 1937, the CCUB went bankrupt. Foreclosure proceedings were instituted in 1938.

At this point the Government of the Province of British Columbia entered the picture by forestalling the threatened action and assumed the mortgages and control of all the land and improvements. Jamieson (52) 1952 further reports this action as follows.

> In this way the Provincial Government assumed trusteeship over some 19,000 acres of land, together with buildings and other facilities, formerly owned by the CCUB Ltd. From one point of view this was a humanitarian gesture on the part of the Provincial Government. It prevented the wholesale dispossession of the Doukhobors. They have been allowed to continue occupying the land and buildings, and have been charged very moderate rentals. Many have paid no rent at all. The total collected, amounting to a few thousand dollars a year, probably does not even cover the costs of administration by the Land Settlement Board, let alone provide a reasonable rate of interest on the Government's

initial investment of $296,500, or reimbursement for the tax revenues that have been sacrificed.

From another point of view, however, the Provincial Government put itself in a dubious position which has greatly complicated the problem of its relationships with the Doukhobors. There is the legal aspect for one thing. Under foreclosure action, land and other assets are supposed to be sold at a public auction after due notice has been given. The government forestalled this action and took over the land and buildings en bloc, for a lump sum well under the probable return from auction sales in individual parcels. Or, to put it another way, the Provincial Government for the sum of $296,500 acquired control over land and buildings in which the Doukhobors had invested millions of dollars plus work. Despite the considerable deterioration in land and buildings that has occurred during and since the 1930's, at present inflated prices these assets would probably be worth well over a million dollars.

The main problem arising out of this situation lies in its effects upon the attitudes of the Doukhobors themselves. Not only is there widespread apathy and discouragement as a result of the collapse and liquidation of their great communal enterprise; there is also a widespread suspicion, which a mere presentation of the facts alone will not dispel, that they were "gypped" by the mortgage and trust companies and by the Provincial Government. At the time of the foreclosure they had repaid in interest and principal the major part of their indebtedness. Not knowing the technical details and cost involved in the foreclosure proceedings, many suspect that the creditors collected far more from the sale of CCUB assets than was owing to them, and many likewise feel that the Provincial Government "pulled a fast one" in gaining control of some 19,000 acres of land and buildings for less than $300,000.

Partly because of their insecure position as tenants and squatters, the Doukhobor occupants have been unwilling to maintain and improve the land, buildings and other facilities. Large tracts are remaining uncultivated. Houses and other buildings, irrigation facilities, and the like, are being allowed to deteriorate or break down entirely. To an increasing degree since the final collapse and liquidation of the CCUB Ltd., Doukhobors have been abandoning farming and have been working at other employments. This has brought a corresponding tendency towards dependence upon city or town for recreational life.

In summary, it is evident that the Doukhobor problem in British Columbia began at the time the Doukhobors purchased the land now under study in the West Kootenay and Grand Forks areas of British Columbia. Although great enthusiasm and hard work went into the development of the lands there is evidence of an almost complete lack of direction and technical planning. As a result the irrigation and cropping practices have been unsuccessful and the land now largely lies idle.

DESCRIPTION OF AREAS

The Doukhobor lands of British Columbia lie in the south eastern section of the province and their locations may be noted from Figure 1. The lands occur in two general areas, the Grand Forks area and the West Kootenay area.

The names used here to identify the various blocks of land, designated as communities, are the same as those used in the Report of the Doukhobor of British Columbia (52) 1952 and are the names in common usage in the areas at the present time. Legal descriptions, areas and numbers of all lots involved are listed in the report of the Department of Lands and Forests (18) 1953.

GRAND FORKS AREA

Location and Extent

The Doukhobor lands of the Grand Forks area lie within the Similkameen Land District and comprise 5,327 acres. The largest block is located a few miles west of Grand Forks city which is on the southern trans-provincial highway nearly 400 miles east of Vancouver, B. C. This block is 4,716 acres in size and though irregularly shaped is bounded on the south by the international boundary and extends about 3.5 miles north up July creek valley. Another section extends about the same distance up the east side of the Granby (North Fork) river valley ending just below the recently drained Smelter Lake basin.

Further up the Granby river lying on a gravel highway is another block of 175 acres now designated as Caesar but formerly known as Grahams Ranch. One other small area of 436 acres, Gilpin, is situated about 7 miles east of Grand Forks on the south side of the Kettle river. Gilpin is not properly a former CCUB holding but since a number of the Sons of Freedom sect occupy this block it was included in the survey.

Transportation and Amenities

The largest block of land is traversed by British Columbia paved Highway Number 3. From this highway a gravel road extends up the west side of the Granby river serving the northeast section of the block and the Caesar community.

Gilpin community is the most inaccessible parcel. Some of the residents reach it from the main highway on the north side of the Kettle river by leaving their vehicles there and crossing the river by boat or cable chair. However, at the time of study, the latter had been sabotaged and did not operate. An alternate route existed along the south side of the river over a poor and winding logging road.

Railway services are provided by the Canadian Pacific Railway, Kettle Valley line with daily passenger and freight services to east and west (19) 1954. The Great Northern Railway operates a spur line for freight only, to Spokane. Greyhound bus lines and a number of truck lines have scheduled trans-provincial and trans-continental service. There is a small municipal airport with no scheduled airline service but used for emergency and private landings. The nearest main airports are at Castlegar 75 miles to the east and at Penticton 125 miles to the west.

Although power and telephone lines cross most of the Doukhobor lands neither of these facilities were found installed in homes on these lands.

In Grand Forks city there is one elementary and one junior-senior high school which are attended by children of the community lands. Another elementary school is located a number of miles up the Granby valley. One small 27 bed hospital and volunteer fire brigade also serve Grand Forks. Many other services of the independent trades and businesses are available to the city.

Industry and Development of the Area

The Grand Forks area has a population of 4,700 in 1954 as compared with 4,056 residents in 1941 (19). Although original development was based on mining, the economy now depends on agriculture, forestry and lumbering operations. The lumber industry produced 13,270 thousand feet board measure in 1953 and employed about 180 men (19) 1954. Mining activity is now limited to one limestone quarry at Fife.

There are two operating irrigation districts but neither provide water to the Doukhobor lands. In the Grand Forks district there are 2,500 irrigated acres, and in the Covert district, 280 acres are irrigated. In addition, over 120 acres are privately irrigated. These irrigated lands produce mainly seed potatoes of high quality along with flower and vegetable seed and some tree fruits and grain. In the Granby valley dry farming is practiced, the main emphasis being placed on hay and pasture crops for dairying and beef cattle production. One commercial dairy has been established in Grand Forks (19).

Climate

Grand Forks has a dry sub-humid climate

in the classification of Thornthwaite (46) 1948. The rainfall and temperature values for Grand Forks station are listed in Table 3 and a number of other stations are included in this table for comparison.

It should be noted that all the recording stations are located in the valley bottoms and therefore are indicative of climatic conditions only at the lower elevations. It will be noted that the annual rainfall at Grand Forks is 16 inches. This is 5 inches higher than the annual rainfall at Penticton. Difference in summer rainfall between the two points, however, are not so great.

With regard to temperature, the climate of Grand Forks shows the greatest extremes of the stations listed. It has the highest average mean temperature in July, 69°F and the lowest average mean temperature in January, 19°F.

The frost free period, shown in Table 3, is the number of days between the last day in spring when the temperature falls below 32°F and the first in the fall when the temperature again falls below 32°F (8). Comparing stations listed in Table 3 it is seen that the frost free period for Grand Forks, 130 days, is less than that for Nelson, 144 days, or for Penticton, 149 days. The frost free period for Grand Forks, however, is quite satisfactory for the growth of crops normally raised in the area.

TABLE 3

CLIMATIC DATA FOR GRAND FORKS, NELSON, PENTICTON AND KELOWNA

	Mean Temp.[1] (°F)			Frost-free[2] (Days)	Growing Season[3] (Days)	Precipitation[1] (Ins.)		Thornthwaites' Data[4] (Ins. Annual)	
	July	Jan.	Ann.			June July Aug.	Ann.	Potential Evapo-transpiration	Net moisture Deficiency
Grand Forks	69	19	45	130	205	3.75	16.26	25.95	12.86
Nelson	67	25	46	144	199	5.46	28.02	24.18	6.77
Penticton	68	27	48	149	218	3.05	11.35		
Kelowna	67	25	46	144	204	2.84	12.38	24.8	13.00

1 Climate of British Columbia, B.C. Dept. Agric. 1952

2 Frost-free Season in British Columbia, Can. Dept. of Transport, 1949

3 Brink, V.C. Climates of British Columbia for Agrologists. Part 1 Unpub. Tech. Comm. Agron. Dept. U.B.C., Vancouver, B.C.

4 Calculated by Thornthwaites Method (46)

The growing season shown in Table 3 is the number of days in which the average daily temperature rises above 43°F (8). It is considered a good criterion for assessing and comparing climates for plant growth since it is an average value, and is not greatly affected by abrupt drops in temperature. The growing season for Grand Forks, 205 days, falls between those for Nelson and Penticton. It would not be a restricting factor for the production of most crops.

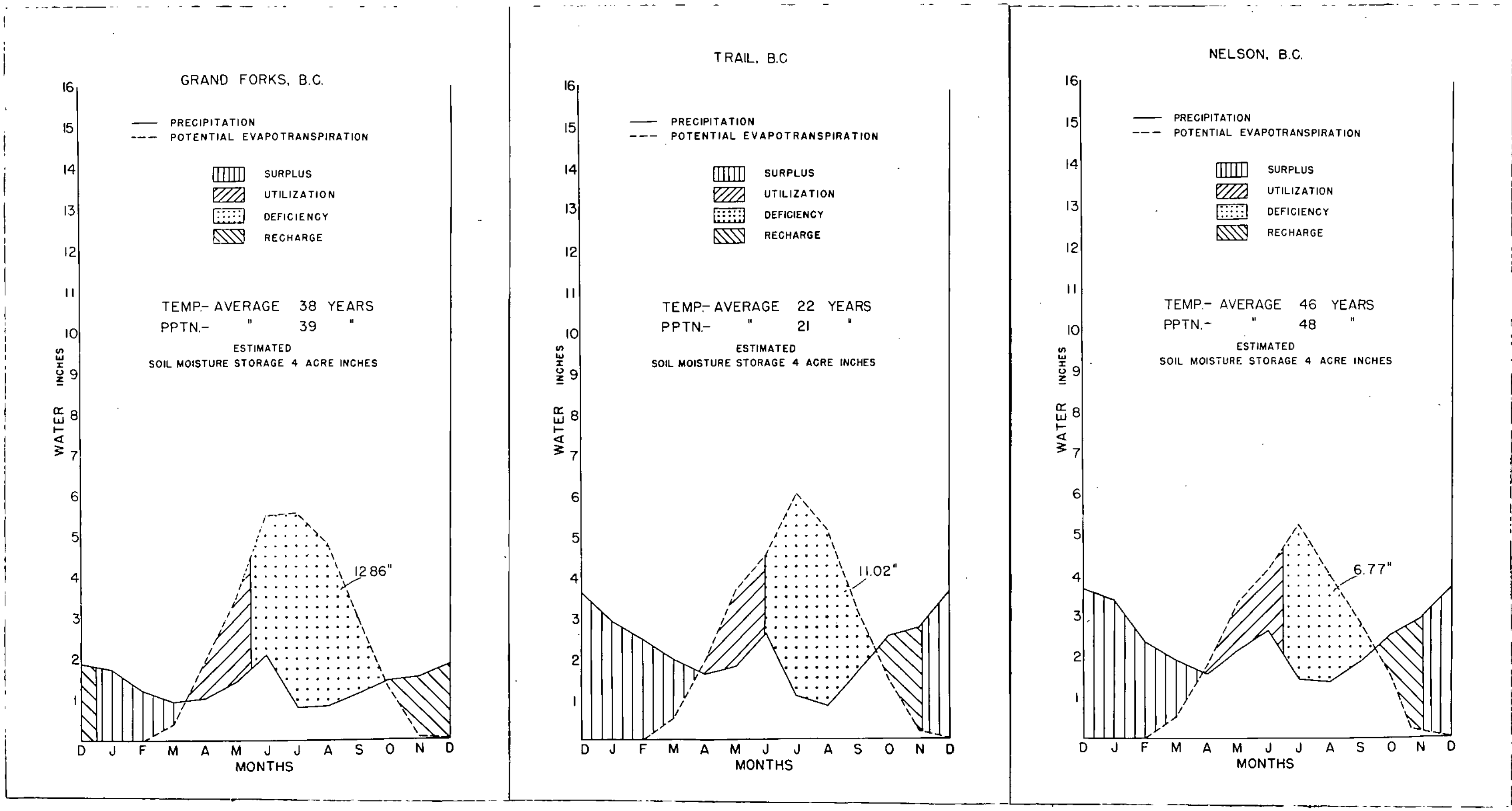
The Thornthwaite (46) 1948 evapostranspiration data was calculated, as shown in Table 4, and the results are given in Table 3 and shown graphically in Figure 2. In constructing these curves the soil moisture storage capacity of 4 inches, suggested by Thornthwaite was used. It should be noted however that this figure is somewhat higher than the average for the soils under study.

Figure 2 shows a calculated moisture need of 12.86 inches occuring at Grand Forks from mid-May through the growing season to late September. This is very similar to that reported for Kelowna, 13.00 inches (53) and suggests a similar water deficiency for the two points.

Vegetation

Both forest and grassland vegetation occur in the area. The south and to some extent the east

FIGURE 2



PRECIPITATION AND POTENTIAL EVAPOTRANSPIRATION AT SELECTED STATIONS

TABLE 4

COMPARISON OF EVAPOTRANSPIRATION DATA FOR NELSON, TRAIL AND GRAND FORKS[1]

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
NELSON (elevation, 2,235 ft.)													
Pot. Evapotrans. (unadj.) cms.	0	0	1.3	4.1	6.4	7.8	9.8	9.2	6.8	4.2	0.8	0	
Pot. Evapotrans. (adjust.) ins.	0	0	0.53	1.80	3.34	4.15	5.25	4.52	2.83	1.52	0.24	0	24.18
Precipitation, ins.	3.40	2.36	1.92	1.59	2.17	2.65	1.45	1.39	1.87	2.53	2.94	3.68	27.95
Water storage, ins.	4.00	4.00	4.00	3.79	2.62	1.12	0	0	0	1.01	3.71	4.00	
Storage change, ins.	0	0	0	-0.21	-1.17	-1.50	-1.12	0	0	1.01	2.70	0.29	
Water deficiency, ins.	0	0	0	0	0	0	2.68	3.13	0.96	0	0	0	6.77
Water surplus, ins.	3.40	2.36	1.39	0	0	0	0	0	0	0	0	3.39	10.54
TRAIL (elevation, 1,982 ft.)													
Pot. Evapotrans. (unadj.) cms.	0	0	1.3	4.3	7.0	8.5	11.2	10.4	7.6	4.0	0.6	0	
Pot. Evapotrans. (adjust.) ins.	0	0	0.53	1.96	3.69	4.55	6.04	5.16	3.19	1.49	0.18	0	26.79
Precipitation, ins.	2.94	2.50	2.00	1.63	1.81	2.61	1.06	0.82	1.64	2.52	2.72	3.64	25.89
Water storage, ins.	4.00	4.00	4.00	3.67	1.79	0	0	0	0	1.03	3.57	4.00	
Storage change, ins.	0	0	0	-0.33	-1.88	-1.79	0	0	0	1.03	2.54	0.43	
Water deficiency, ins.	0	0	0	0	0	0.15	4.98	4.34	1.55	0	0	0	11.02
Water surplus, ins.	2.94	2.50	1.47	0	0	0	0	0	0	0	0	3.21	10.12
GRAND FORKS (elevation, 1,746 ft.)													
Pot. Evapotrans. (unadj.) cms.	0	0	1.0	4.79	8.58	11.25	13.91	12.02	7.46	3.16	0.15	0	
Pot. Evapotrans. (adjust.) ins.	0	0	0.41	1.94	3.43	5.50	5.56	4.81	2.98	1.26	0.06	0	25.95
Precipitation, ins.	1.74	1.21	0.95	1.04	1.44	2.09	0.81	0.84	1.14	1.45	1.53	1.86	16.10
Water storage, ins.	4.00	4.00	4.00	3.10	1.11	0	0	0	0	0.19	1.66	3.52	
Storage change, ins.	0	0	0	-0.90	-1.99	-1.11	0	0	0	0.19	1.47	1.86	
Water deficiency, ins.	0	0	0	0	0	2.3	4.75	3.97	1.84	0	0	0	12.86
Water surplus, ins.	1.26	1.21	0.54	0	0	0	0	0	0	0	0	0	3.01

1 Temperature and precipitation data from Climate of British Columbia, Prov. Dept. Agric. 1950

facing slopes are grass covered, consisting of native short grasses, some wheat grasses, rye grasses and koeleria. Some of the small gulleys that receive seepage support vetch and sweet clover. Where overgrazing has been permitted rather poor quality forage plants such as downy brome, cheat, sowthistle, knapweed and Russian thistle tend to take over.

Forest vegetation covers the north facing slopes where moister and cooler conditions prevail. Several tree species occur including fir, cedar, hemlock, pine and larch. The forest undercover consists of chokecherry, snowberry, rose and numerous other small shrubs. The forest on the community lands supplies residents with fuel, poles and posts. On some communities timber is quite heavily cut so that supplies for these needs must be sought elsewhere.

Much of the community land once was regularly cultivated or supported orchards. Now, however, the orchards are unattended and are becoming decadent. Many of the cultivated areas were allowed to go back to wild vegetation, but some were seeded to grass or alfalfa and produce a fairly good hay crop each year. The balance of the land including old orchard lands are merely used for summer pasture of milk cows. On some of the better soil types small plots are used for the production of cereal crops.

Physiography and General Geology

The Grand Forks area is mountainous with rounded summits rising up to 5,000 feet elevation. Below this level two main valleys traverse the area. The Kettle river enters Canada near the customs port of Danville, elevation 1,733 feet, and then turns east, nearly parallel to the border, for about 15 miles where it flows back into the United States. The valley in which it flows is U-shaped and filled with alluvial sediments at least 50 to 150 feet deep. It is into these sediments that the Kettle river has cut a deep meandering trench. The Granby river enters this valley from the north just east of Grand Forks, elevation 1,737 feet, through a narrow rock walled gorge. The valley of the north fork is also U-shaped and sediment filled but the river has not entrenched itself quite as deeply as has the Kettle.

At the confluence of these two valleys a broad flat terrace area of sediments has been built up just west of Grand Forks. The Doukhobor lands occupy a part of this terrace area. It was probably deposited while valley glaciers retreated in late pleistocene time. Evidence of this is seen in the kettle topography developed by the melting of the last remaining ice blocks just above the terrace level.

A smaller narrower valley which contains

July creek runs north from the border on the western side of the Doukhobor lands. It, too, is U-shaped showing evidence of glacial erosion but its walls are very steep and it contains very little sediment. At present the creek is further entrenching itself along a rather straight course.

Daly (11) 1912 estimates that the ice cap at one time covered the valleys to a depth of 4,500 feet. He concluded that the ice has done very little erosion work on the bedrock but that most of its work was done in depositing and transporting debris. All the upland areas are heavily covered with glacial drift.

Brock (6) 1905 also explains that most of the area is drift covered and that clays, silts, sands and gravel are widespread being found along large valleys, where protected by the topography of the country, in well marked terraces.

The soil parent material therefore is largely made up of rock debris and sediments of glacial origin consisting of terraces, fans and till which were further modified by erosion and deposition.

Since the glacial movements were varied and widespread it can be seen that the nature of material deposited by their action will be heterogeneous and may contain many combinations of minerals and rocks that outcrop in the vicinity.

According to the map of Brock (6) 1905 a rather varied arrangement of rocks outcrop in this vicinity. Sedimentary, altered sedimentary and volcanic rocks are common. Most of them are of basic nature. Included in the sedimentaries are a number of limestones occurring as pods and lenses in the highly folded strata. Enough of these outcrop to make the till in the area highly calcareous and the soils developed on it were calcareous at a depth of one to three feet. Some of the soils on heavier textured alluvial material were also calcareous in the lower horizons; very few coarse textured soils of alluvial origin had lime accumulation in the profile, although faint traces may be found at depth.

WEST KOOTENAY AREA

Location and Extent

The West Kootenay region of British Columbia includes the area drained by the Kootenay river and its tributaries beyond the point where it leaves the Rocky Mountain trench and enters the Selkirk mountains in the vicinity of Creston and continues west approximately to Christina lake. However, as used in this study, West Kootenay refers only to those blocks of land situated in the valleys between Trail and Slocan.

The Doukhobor lands of the West Kootenay, 13,545 acres, are contained partially by the Columbia river valley from the Champion Creek community, 9 miles north of Trail, to Brilliant, partially by the Kootenay river valley from its junction with the Columbia at Brilliant to Shoreacres and then partially by the Slocan river valley north to Perry Siding (see Figure 1).

The most southerly block of land referred to as Champion Creek comprises 920 acres. It lies on the east side of the Columbia river about 9 miles north of Trail. Ooteshenie, 4,000 acres, and Brilliant and Raspberry, 1,019 acres in all lie in a contiguous block immediately north of Champion Creek at the confluence of the Columbia and Kootenay rivers. Glade community, a block of 963 acres, lies on the east side of the Kootenay river between the point where the Slocan river enters it and Tenmile creek at the southern edge of the community. Shoreacres, 631 acres, is situated just above the junction of the Slocan and Kootenay rivers. It is separated into two parcels by the Kootenay rivers. The part on the east side lies on a high gravelly terrace with soil of poor quality and at present is uninhabited. Lying along Goose creek and west of the Slocan river, Krestova community makes up 2085 acres, Pass Creek community, 2,590 acres, lies south-west of Krestova and north of Raspberry in the Norns (Pass) creek valley. The Pass Creek block and the Krestova block are separated by only a short distance. Norns creek and the Kootenay river valleys are almost parallel and are separated by a narrow rocky ridge -- Sentinel Mountain -- which lies in a northeast to southwest direction on the west side of the Kootenay valley.

Five small communities lie along the Slocan river and are named after the railway stations nearby. In order, from south to north they are Koch Siding 192 acres, Lebahdo 314 acres, Winlaw 223 acres, Claybrick 344 aeres and Perry Siding 264 acres.

Transportation and Amenities

Residents of Champion Creek on the east bank of the Columbia river are obliged to reach the community by a long tortuous road from Brilliant or by crossing the river by boat from the main provincial highway across the river. One elementary school serves the area.

Ooteshenie, Brilliant, Raspberry and Shoreacres are within easy reach of the paved provincial highway and only a few minutes drive from Castlegar. The Castlegar airport lies in Ooteshenie area. An elementary school is nearby.

Glade community is completely inaccessible by road. There is a small private barge capable of ferrying one vehicle at a time across the Kootenay river and many of the residents keep their cars on the west side of the river and row across in small boats.

A dirt road enters Pass creek valley through Raspberry community traversing the Pass Creek community and continuing through Krestova where it crosses the Slocan river and joins the main gravel highway in the Slocan valley. There is one elementary school at Pass Creek and a junior-senior high school at South Slocan.

All Slocan valley communities except Winlaw lie on the main gravel highway to Slocan city. Winlaw can be reached by crossing the bridge at Vallican or Appledale and following a gravel road. Schools, post offices and small stores are easily available to all of these communities. Senior high schools and other amenities are available at Nelson, Trail and Castlegar. Hospital service is available at Nelson, Trail, Rossland and New Denver.

Electric power and phone lines cross many of the Doukhobor communities but none have availed themselves of these services.

The area is well supplied with transportation facilities. The Canadian Pacific Railway, Kettle Valley line, runs daily to Vancouver and Calgary. A weekly train goes up the Slocan valley to Slocan city and a freight service operates to Trail. There are numerous truck lines hauling freight on the main roads. Buses operate daily on all main highways and connect with transcontinental services. The Castlegar airport located just south of Brilliant has scheduled airline flights daily except Sunday to Vancouver and Calgary.

Industry and Development in General Area

The West Kootenay region, population 63,000 (1954), is one of the more heavily industrialized sections of the interior of the province and employment is nearly always available.

The 1953 production of lumber was 141 million feet board measure employing about 2,000 men (19).

In 1953 this region accounted for 17 percent of the value of all British Columbia mineral production (19). Apart from this there is the city of Trail, population 22,000 (1954) which is sustained almost entirely by the operation of the Consolidated Mining and Smelting Company Ltd. It produces all of

Canada's refined lead, antimonial lead, bismuth, indium and a major part of Canada's slab zinc, refined silver and refined cadmium.

Approximately 6,500 acres are now under irrigation (19) of this about 378 acres are irrigated on former community land (18). The only community to operate an irrigation system on an efficient basis at the present time is Raspberrry which sells fruit commercially. Residents of the Slocan valley communities are able to set up small pumping plants for irrigation and one or two families in each of these communities appear to support themselves by full time farming. One family at Winlaw, maintains a herd of approximately one dozen milk cows.

In contrast to the limited, inefficient agriculture on the community lands, there are many thriving farms set up by independent operators on adjacent lands.

Climate

In general, the area can be classed as moist subhumid to humid (46), characterized by hot summers and cool but not severely cold winters. Due to mountainous terrain local variations in climate are marked but the data of selected stations in Table 5 gives a good indication of the region as a whole. However, it should be noted that most of the stations

TABLE 5

CLIMATIC DATA FOR WEST KOOTENAY STATIONS AND GRAND FORKS

	Mean Temp.[1] (°F)			Frost-free[2] (Days)	Growing[3] Season (Days)	Precipitation[1] (Ins.)		Thornthwaites' Data (Ins.Ann.)[4]	
	July	Jan.	Ann.			June July Aug.	Ann.	Potential Evapo-transpiration	Net Moisture Deficiency
Trail	70	23	48	186	206	4.40	25.98	26.79	11.02
South Slocan	69	22	47	157	205	5.59	31.12		
Nelson	67	24	46	144	199	5.46	28.02	24.18	6.77
Crescent Valley	65	21	44	97		5.07	29.49		
Perry Siding				117	195	4.08[5]	23.82[5]		
Grand Forks	69	19	45	130	205	3.75	16.26	25.95	12.86

1 Climate of British Columbia, B.C. Dept. Agric. 1952

2 Frost-free Season in British Columbia, Can. Dept. of Transport, 1949

3 Brink, V.C. Climates of British Columbia for Agrologists. Part 1 unpub. Tech. Comm. Agron. Dept. U.B.C., Vancouver, B.C.

4 Calculated by Thornthwaites' Method (46)

5 Climatic Data of British Columbia, B.C. Dept. of Agric. Hort. Branch,1932

are located in valley bottoms. Data for Grand Forks is included in the table for comparison.

It will be noted from Table 5 that precipitation in the area ranges from 23.8 inches to 29.5 inches and about one third of this falls as snow. If the ground is not frozen in the autumn before snowfall much of the melting snow soaks into the soil and is present in the soil at the start of the growing season.

Going from south to north the mean temperatures are seen to decline, the average July temperature being 5 degrees cooler at Crescent Valley station just across the Slocan river from Krestova community, than at Trail. The Slocan valley is generally considered to be even cooler. This is evidenced by a shorter frost free period and growing season at Perry Siding, 117 days and 195 days respectively, than at Trail, 186 days and 206 days, or Nelson, 144 days and 199 days.

The short frost free period of 97 days at Crescent Valley, elevation 1564 feet, as compared to 157 days at South Slocan, elevation 1628 feet shows the great variation possible in mountainous country. In this regard local reports show that garden vegetables are frozen more frequently in the Upper Goose creek valley than in the South Slocan area.

The growing season shows a decrease going from Trail, 206 days, to the Slocan Valley (Perry Siding, 195 days) though the difference is only 12 days. The growing season for South Slocan is similar to that for Grand Forks, 205 days. With the exception of certain unfavorable areas the growing season for the points listed is quite sufficient for the production of the crops that are raised.

Thornthwaite evapotranspiration data (46) was calculated, as shown in Table 4, for the Trail and Nelson recording stations and the results are given in Table 5 and shown graphically in Figure 2. It will be noted that Trail has a high potential evapotranspiration value, 26.79 inches, and a high moisture deficiency, 11.02 inches. For Nelson these values were 24.18 inches and 6.77 inches respectively. These figures show that irrigation would be important at both stations, and that the greater benefit would be noted at Trail.

The high total precipitation at Crescent Valley does not indicate a lower summer moisture deficiency since the average summer rainfall at that station is very little higher than the average summer rainfall for any other station tabulated. Climatic data for Perry Siding, in the north, is rather incomplete. No temperature figures are available and the precipitation figures are recorded to 1932 only. According to these figures the average summer rainfall at Perry Siding is the lowest in the West Kootenay area and on this basis it would seem that the moisture deficiency would be quite high. However, to satisfactorily evaluate this condition, temperature would have to be taken into account.

On the basis of the available climatic data and considering the nature of the soils, it appears that irrigation would be essential to any type of successful intensive agriculture in the West Kootenay area.

Vegetation

As indicated previously, when the lands in the West Kootenay were first settled by the Doukhobors they were heavily forested, the principal species being fir, larch, cedar and white pine. The merchantable timber was soon harvested, and the land either cleared for agriculture or allowed to go wild. Much of the land now in trees shows evidence of intensive logging and regeneration is slow. Continued cutting of trees for community needs of fuel, poles and posts in the more accessible areas has resulted in the cover becoming principally scrub in the form of willow and hazelnut.

Physiography and General Geology

The Doukhobor lands in the West Kootenay area may be considered as lying in one continuous "valley" running in a north to south direction and being made up of parts of three main river valleys, Slocan, Kootenay and Columbia, with an adjacent side valley starting at the mouth of Goose creek continuing about 5 miles up its course and then down Pass creek valley to its junction with the Columbia river.

This "valley" shows much evidence of glaciation. It is generally U-shaped with steep valley walls, the outcrops of which are polished and show some glacial striae and grooves. The surrounding mountains are made up of mainly granitic rocks in the form of rounded knobs. The northerly and easterly slopes are generally steeper and have the appearance of being quarried since they have been more subject to erosion by glaciers than the other sides. Occasional sharp peaks with cirque valleys rise in distance to 8,000 or 9,000 feet elevation. These probably stood as nunataks above an old ice sheet.

No geological report covers these areas in particular but general statements in reports of nearby areas indicate that the whole area of interior

British Columbia was once covered by a great depth of ice. Drysdale (12) 1915 in his report on Franklin Mining Camp west of the Lower Arrow lake states,

> . . . . The Cordilleran ice sheet covered the region with the possible exception of a few high peaks on the Cariboo range, which stood as nunataks above the ice surface. It but slightly modified the upland topography, leaving striae and scourings in places, but on retreating left morainic drift and erratics stranded high on the upland.
>
> The ice cap gave place to alpine valley and cirque glaciers[1] which slowly retreated until the time of the Keewatin ice sheet extension to the east, when the second main period of valley glaciation took place. It is to this period that the strongly glaciated valley forms (such as U-shaped valleys, lateral moraines, striae, etc.) owe their origin, and the valley trains of outwash material were deposited.......
>
> . . . . With the retreat of the valley glaciers the streams, unburdened of their morainic load, began to degrade their valley fills. A series of terrace-steps mark successive periods of aggradation and degradation dependent upon climatic oscillations.......
>
> 1 First period of valley glaciation.

The preliminary map of the west half of Nelson geological area by Little (28) 1949 shows many glacial striae and drift covered areas.

Most of the soil parent materials are old and recent river terraces laid down in this U-shaped valley during the time that ice occupied the valley and gradually retreated. In many places kame terrace remnants are discernible along the valley walls. When the ice melted these slumped down and have since been eroded and dissected to their present form. They do not constitute a very large area and for the purpose of classifying the soils have been included with the river terraces, their characteristics being similar.

The main river terraces of each area lie at approximately the same height above present river level indicating they were all laid down at the same time and possibly by the same river. Subsequent geological uplift, or possibly, simply the removal of ice blocks, has allowed the rivers to cut down through the original deposits to their present positions.

The terraces, vary in texture from loamy coarse sand to gravelly sandy loam and sandy loam. Some of the lower terraces are of slightly finer texture varying from fine sandy loam to loam.

In addition to the terraces there are stream fan deposits laid down at the mouth of entrant side valleys and partially burying the terrace materials. There are also colluvial fan deposits, covering small parts of the terraces, and brought down the valley walls by gravity or a combination of gravity and water action. Characteristically all these fan deposits have boulders and coarse materials at their apices, and an increasing amount of finer materials toward the toe of the fan where the gradient lessens.

Many recent deposits of small area, have been laid along the present river channels and now stand 10 to 20 feet above them. This has occurred in the Slocan valley particularly where the river's meander belt is much wider than that of the Columbia river. There are very few recent deposits along the Kootenay river as its walls are steep and confining. Small alluvial deposits have built up along the beds of Pass and Goose creeks where their gradients are low.

No deposits of glacial till were found on the community lands, probably because the valley walls are all excessively steep and any till deposits on moderately sloping ground are covered by alluvium. However, a few outcrops of glacial till were observed along the road to Nelson just east of South Slocan where more moderately sloping topography is found above terrace level.

The main mass of country rock appears to be similar to that identified in the Nelson area by Little (28) 1949. In this paper Little reports great areas of predominantly acidic rocks; granite, granodiorite, quartz diorite, andesite and a host of other mixtures lying immediately east of the Doukhobor lands. Very few limestone or marble outcrops appear and these only in the eastern part of the area described by Little. Drysdale (12) 1915 reporting on the Franklin Mining Camp area, which lies about 15 miles west of the Lower Arrow lake, shows that a varied mixture of both acidic and basic rocks outcropping. He found very few limestone outcrops.

From the existing evidence and available reports it is evident that the principal soils of the West Kootenay area are derived from acid and moderately basic rocks strongly affected by glaciation and it is interesting to note that no calcoreous parent material of any significant area was found on the West Kootenay Doukhobor lands.

SOILS

Methods of Field Survey

Soils of the Doukhobor lands were examined, classified and mapped in the field. Traverses were made by car and on foot, and the soils were examined and described using profile pits dug at strategic intervals in relation to soil boundaries. The soils were described in accordance with recognized procedures (1) (50) (51), and the criteria summarized below were used to characterize the soil profiles (1).

1. Number of horizons in the soil profile.
2. Colour of the various horizons, with special emphasis on the surface one or two.
3. Texture of the horizons.
4. Structure of the horizons.
5. Relative arrangements of the horizons.
6. Chemical composition of the horizons.
7. Thickness of the true soil.

8. Thickness of the true soil.

9. Character of the soil material.

Other features relative to soils and noted in the field were the elevation, slope, vegetation and present use of the land.

The plotting of boundaries separating different soils was greatly facilitated by the use of aerial photographs. These photographs were supplied by the Air Surveys Division of the Department of Lands and Forests and were of a scale of approximately one foot to one mile.

While in the field, a site was carefully selected to represent the modal profile for each of the soil types classified and mapped. These profiles were described in detail and samples taken from each horizon for laboratory determinations.

In classifying the soils of the Doukhobor lands, the field system of classification adapted by the National Soil Survey Committee was followed (26) (37). This system provides for classifying soils into six categories proceeding from the broadest grouping as follows, Zones, Subzones, Catenas, Series, Types and Phases. The definitions of these categories as set down by the National Soil Survey Committee is as follows (37).

The soil zone was defined as "a broad

belt of soils in which the dominant 'normal' soils belong to one of the Zonal Great Soil Groups." The committee further stated that "the dominant soil forming processes in a zone are towards the formation of a definite genetic type of soil" (Zonal Great Soil Group) and that climate and vegetation are dominant factors in determining these soil forming processes.

Although the use of soil subzones has been rather limited the following definition was suggested, "fairly consistent broad variations within a zone, which can be linked with gradual climatic and vegetative changes and which may or may not be accompanied with changes in parent materials.

The Catena is the first subdivision of the soil zones and is outlined by the National Soil Survey Committee as follows.

> The catena is considered as a group of soils on similar parent materials within a soil zone. It includes the entire range of soils produced under different local moisture relationships on the same parent material. It is recognized that soils have depth, width and breadth and that they may vary in all three dimensions. There often is no sharp division between the individual soils and one gradually merges into another. This entire range of soils in a catena often, but not always forms a definite mappable land pattern.

Catenas are further subdivided into soils series on the basis of profile characteristic differences as described below.

> The Catena comprises all the soils which have developed under the entire range of soil moisture conditions which exist on the same parent material within a soil zone. The catena thus contains a continuous range of soils or profiles which can generally be broken into segments and which have variously been recognized as soil series, associates or members.

The soil series mapped in this study usually included soils of varying texture and they were divided into soils types on this basis in accordance with the procedure outlines by Leahey and Stobbe (27) as follows.

> While the soil series is considered to be the basic unit of soil classification in Canada it is sometimes desirable and possible to sub-divided soil series on a textural basis. Such divisions are known as soil types. However, the textural range within a series is seldom very wide and the general tendency is to establish mono-type series. If all series were confined to one textural range the need for this category would of course disappear.

The external features of topography and stoniness affect the use of soil for agriculture. Where possible these differences were mapped and classed as phases of their respective soil type (27).

Such a field system of soil classification is desirable since it indicates the relationship of areas of related soils and the land patterns they create. It also takes into consideration certain pedological characteristics but it frequently allows soils of greatly varying morphological characteristics to be grouped closely together. To overcome this bias the morphological system of soil classification can be utilized and this is discussed by Leahey and Stobbe (27), in part, as follows.

> In this system the soil series is regarded as the basic unit of classification and hence the series and its sub-divisions are the same as in the previously described system. The difference between the two systems lies in the grouping of the soils into higher categories. In the morphological classification the soil series are grouped into families and families into a great soil groups. The family category has been introduced only recently and in the past the soil series have been grouped directly into great soil groups. The increasing number of series within a great soil group has necessitated the introduction of an intermediate category -- the soil family.

A morphological system of classification was used in the present study ohly to the extent that each soil series recognized was assigned to a Zonal Great Soil Group as indicated in Tables 8A and 8B. The category of Zonal Great Soil Group as used in Canada is described below (27).

> This term has been used in Canada to designate a group of soils having the same general sort of profile. That is, the soils within a great soil group must be of the same genetic type. This unit of classification has served a very useful purpose in Canada as it

> assists in the cataloguing of soils of the same genetic type although it is not suitable for cartographic purposes. The Great Soil Group should not be confused with a Soil Zone. Whereas the former represents a definite genetic type of soil, the latter is a geographic area which may contain a number of great soil groups but in which one definite genetic type is dominant.

In classifying the soils of the Doukhobor lands a number of miscellaneous groups were used for areas of land that have little or no natural soil, are inacessible or cover too small an acreage to be mapped (50). These miscellaneous types -- bottomland, saline seepage, peat, dune, eroded and dissected, and rough mountainous -- are described in detail under the section on soil descriptions.

Two other soil mapping units, the soil complex and the undifferentiated soil group (50), were also used in classifying the soils. The soil complex was used at the series level to include soils of widely varying texture and drainage.

The undifferentiated soil group may be used for mapping taxonomically similar soils that are not regularily geographically associated (50). In this study the two undifferentiated groups were made up of soils that belonged to the same Zonal Great Soil Group but that varied greatly in texture, slope and stoniness. Much of the area covered by these groups was considered non-arable and so did not warrant separation into smaller units.

While the soil boundaries were being established in the field, the topography was classified and the boundaries of the recognized topographic phases were plotted on the aerial photographs. The percent slope was measured with an Abney level and the slopes classified in accordance with the ranges suggested by the Soil Survey Division of the United States Department of Agriculture (50). This classification is outlined in Table 6.

TABLE 6

SLOPE AND TOPOGRAPHIC CLASSIFICATION

Term	Symbol on (a) Map	Symbol on (b) Photograph	Range of Characteristic
Level to gently sloping	A	$T_{1,2\&3}$	0 - 5 percent slope
Sloping	C	T_4	5 - 10 percent slope
Moderately steep	D	$T_{5\&6}$	10 - 25 percent slope
Steep	E	T_7	25+ percent slope
Windblown	W	W	Hummocks 5 - 15 feet high
Kettle	K	K	Depressions up to 25 feet deep

The stoniness of the land was noted and recorded on the photographs by means of symbols. The classes of stoniness (50) and their relation to tillage practices are indicated below.

St_0 No stones or too few to interfere with tillage.

St_1 Tillage interfered with but intertilled crops still practicable.

St_2 Tillage of intertilled crops barely practicable.

St_3 Use of only very light machinery and hand tools, impracticable.

St_4 Use of all machinery impracticable.

Soils that had a stoniness greater than St_2 were classified as a stony phase. The description for Class 3 stoniness, St_3 above, is as follows (50).

> Class 3: Sufficient stones to make all use of machinery impracticable, except for very light machinery or hand tools where other soil characteristics are specially favorable for improved pasture. Soils with this class of stoniness may have some use for wild pasture or forests, depending on other soil characteristics. (If stones are 1 foot in diameter and about 2.5 to 5 feet apart, they occupy about 3 to 15 percent of the surface, and there are about 50 to 240 cubic yards per acre-foot.)

Soil drainage was observed and classified in accordance with the system outlined in Table 7 (50).

TABLE 7

DRAINAGE CLASSIFICATION

Natural Drainage		Surface Runoff		Internal Drainage	
Symbol	Term	Symbol	Term	Symbol	Term
D_1	Excessive	DS_1	Very high	DI_1	Very rapid
D_2	Well	DS_2	High	DI_2	Rapid
D_3	Imperfect	DS_3	Moderate	DI_3	Moderate
D_4	Poor	DS_4	Low	DI_4	Slow
D_5	Very poor	DS_5	Very low	DI_5	Very slow
D_6	None	DS_6	Ponded	DI_6	None

The natural drainage of a soil as indicated in the foregoing table is a combined expression of the surface runoff and internal drainage.

To show the information relative to soil, topography, drainage and stoniness on the aerial photographs symbols were used and arranged according to the four point plan shown below.

$$\frac{\text{Soil} \quad \text{Topography}}{\text{Drainage} \quad \text{Stoniness}} \quad \text{e.g.} \quad \frac{\text{Ch gsl} \quad T_3}{D_1 \quad St_2}$$

This example would indicate an area of Champion gravelly sandy loam with gently sloping topography, excessive drainage and enough stones to make the tillage of intertilled crops barely practicable.

Along with the soil information, data regarding the present use and vegetative cover was also gathered and recorded. This data was used in the preparation of Table 2.

The soil boundaries and other information shown on the aerial photographs were later transferred to base maps of the scale of 400 feet to the inch. These maps were provided by the Land Utilization, Reasearch and Survey Branch of the Department of Lands and Forests and form a part of this thesis. The aerial photographs are presently held by the Department of Soil Science of the University of British Columbia.

Soil Classification

The classification of the soils of the Doukhobor lands of British Columbia is shown in Tables 8A and 8B. This classification is a combination of the field and morphological classifications outlined previously.

The most extensive soils of the area are

PLATE I

A Black soil, the Hardy series, showing average A_1 horizon development.

classed in two groups, the Black and Brown Podzolic. Associated with the Brown Podzolic soils, occupying the less well drained positions, are Low Humic and Humic Glei soils.

The Black soils, mapped only in the Grand Forks area, make up about 3,046 acres or three fifths of the Grand Forks area. They occupy mainly south facing slopes and the largest areas are seen from the southern trans-provincial highway on the south and east treeless slopes of Hardy mountain. Grass vegetation covers all areas of Black soil. In the more arid positions, the soils are shallower and could be considered as belonging to the Shallow Black Subgroup.

The general nature and horizon sequences of the Black soils may be seen in Plate I. These features are in agreement with descriptions of Black soils described elsewhere (24) (33) (51).

The Brown Podzolic soils are mapped in both the Grand Forks and West Kootenay areas and in those areas comprise 1,683 acres and 6,288 acres respectively. They make up nearly two fifths of the Grand Forks area, and about one half of the West Kootenay area. In the Grand Forks area they occupy mainly north and west facing slopes and the higher elevations above July creek and on Hardy mountain. In the West Kootenay area Brown Podzolic soils were

TABLE 8A

FIELD CLASSIFICATION OF THE SOILS

OF THE GRAND FORKS AREA

Catena, Series, Type and Phase	Group
A. Soils Derived from Alluvium	
(a) Well drained	
Claypit Series	Black
Claypit silt loam	
Claypit loam, level phase	
Claypit loam, sloping phase	
Boundary Series	Black
Boundary loam, level phase	
Boundary loam, sloping phase	
Granby Series	Brown Podzolic
Granby sandy loam	
Granby silt loam	
Granby loamy sand	
(b) Well to excessively drained	
Carson Series	Black
Carson loamy sand, level phase	
Carson loamy sand, windblown phase	
Carson coarse sandy loam	
Carson sandy loam	
Danville Series	Black
Danville loamy coarse sand	
Caesar Series	Brown Podzolic
Caesar loamy coarse sand	
Caesar fine sand	
B. Soils Derived from Glacial Till and Till Derivatives	
(a) Well drained	
Hardy Series	Black
Hardy loam, level phase	
Hardy loam, sloping phase	
Hardy gravelly loam, sloping phase	
Hardy gravelly loam, moderately steep phase	
Hardy gravelly sandy loam, level phase	
Hardy gravelly sandy loam, kettle phase	
Hardy stony loam, undifferentiated	
Gibbs Series	Brown Podzolic
Gibbs gravelly loam	
Gibbs gravelly sandy loam, sloping phase	
Gibbs gravelly sandy loam, kettle phase	
Gibbs stony loam, undifferentiated	
C. Soils Derived from Colluvial Slopes and Fans	
(a) Well to excessively drained	
Rideau Complex	Brown Podzolic
D. Miscellaneous Soils	
Bottomland	
Saline Seepage	
Rough Mountainous	
Eroded and Dissected	

TABLE 8B

FIELD CLASSIFICATION OF THE SOILS

OF THE WEST KOOTENAY AREA

Catena, Series, Type and Phase	Group
A. Soils Derived from Alluvium	
(a) Well drained	
Shoreacres Series	Brown Podzolic
Shoreacres silt loam	
Shoreacres fine sandy loam, level phase	
Shoreacres fine sandy loam, sloping phase	
(b) Well to excessively drained	
Krestova Series	Brown Podzolic
Krestova loamy sand	
Krestova sand	
Krestova coarse sand	
Champion Series	Brown Podzolic
Champion gravelly sandy loam, non-stony phase	
Champion gravelly sandy loam, stony phase	
(c) Imperfectly drained	
Claybrick Series	Low Humic Glei
Claybrick loam	
Claybrick clay loam	
Claybrick loamy sand	
Claybrick gravelly sandy loam, non-stony phase	
Claybrick gravelly sandy loam, stony phase	
(d) Poorly drained	
Pass Creek Series	Humic Glei
Pass Creek loam	
Pass Creek loamy sand	
B. Soils Derived from Colluvial Slopes and Fans	
(a) Well drained	
Glade Series	Brown Podzolic
Glade gravelly loam, level phase	
Glade gravelly loam, sloping phase	
Glade loam	
Glade gravelly sandy loam, non-stony phase	
Glade gravelly sandy loam, stony phase	
C. Miscellaneous Soils	
Peat	
Dune	
Rough Mountainous	
Eroded and Bissected	

found on all the well drained positions. In contrast to the Black soils which developed under grass vegetation, the Brown Podzolic soils developed under forest cover.

The general nature and horizon sequence of the Brown Podzolic soils may be noted from Plate II. This description agrees with the descriptions of Brown Podzolic soils given elsewhere (31) (42) (51).

In contrast with the "Brown Podzolic" soils of the Pacific Coast, (9) very few "shotty structures" were found, and these only to a very limited extent in one series, Shoreacres. Another important difference between many of the Brown Podzolic soils of the Grand Forks area and those of the West Kootenay area was the presence of free lime at a depth of 2 to 3 feet in the former. More extensive field and laboratory studies need to be done to establish conclusively to which Soil Group these Podzolic soils should be assigned. Until this is done, and criteria have been clearly and firmly established, one can only conjecture and tentatively group them with the Brown Podzolic soils.

The Low Humic Glei soils usually occupy positions adjacent to the streams and rivers

PLATE II

A Brown Podzolic soil profile developed on sandy alluvium and showing a very thin A_2 horizon.

and are found on most of the communities in the West Kootenay area. They cover a comparatively small area of soil, 464 acres occuring only in the West Kootenay area. This group of soils developed on almost level topography under the influence of a water table that fluctuates from the surface to about 10 to 20 feet depth. Natural vegetation on these soils consists of scrub trees such as cottonwood and willow with a undergrowth of shrubs and grasses. Most of the areas mapped were cultivated.

The general nature and horizon sequence in these Low Humic Glei soils agrees quite closely with that set out by Thorp and Smith (47) who defined them as follows.

> An intrazonal group of imperfectly to poorly drained soils with very thin surface horizons, moderately high in organic matter, over mottled gray and brown glei-like mineral horizons with a low degree of textural differentiation.

The Humic Glei, fourth group of soils mapped, occupy 316 acres. This group includes the Pass Creek Series mapped in the Pass Creek, Krestova, Lebahdo, Winlaw and Claybrick communities. These soils occur in areas where drainage is restricted; generally the water table is close to the surface throughout most of the year.

The general nature and horizon sequence in the Humic Glei soils may be seen in Plate III.

PLATE III

An intrazonal Humic Glei profile developed on alluvial material in a poorly drained position.

The features are in general agreement with those given by Thorp and Smith (47) who describe Humic Glei soils as follows.

> An intrazonal group of poorly to very poorly drained hydromorphic soils with dark-colored organi-mineral horizons of moderate thickness underlain by mineral glei horizons.......

SOIL DESCRIPTIONS

GRAND FORKS AREA

The soils of the Grand Forks area were classified and mapped into four groups, soils derived from alluvium, soils derived from glacial till and till derivatives, soils derived from alluvial fans and miscellaneous soils. The acreages of each of the soil types mapped in these groups are listed by communities in TABLE 21. In all, 5,327 acres were mapped in the Grand Forks area.

Soils Derived from Alluvium

The term alluvium includes all deposits laid down by streams and rivers (57). These deposits are quite uniformly sorted as to size of particle and may range in texture from cobbly gravelly loamy sand to silt. The alluvium that constitutes the parent materials of these soils was deposited by glacial and post glacial rivers and very little material has been laid down recently.

PLATE IV

Grand Forks area, looking east, with the Kettle river winding through flat terrace land. Doukhobor land lies north of the river where soils of the Danville, Carson and Claypit series occupy the terraces. Foreground is Hardy stony loam undifferentiated.

The alluvium is, on the average, one to two hundred feet deep and forms the terraces that may be seen in Plate IV. Coarse textured substrata usually underlie the medium to heavy textured surface layers on the terraces.

Six series covering 823 acres make up the soils derived from alluvium.

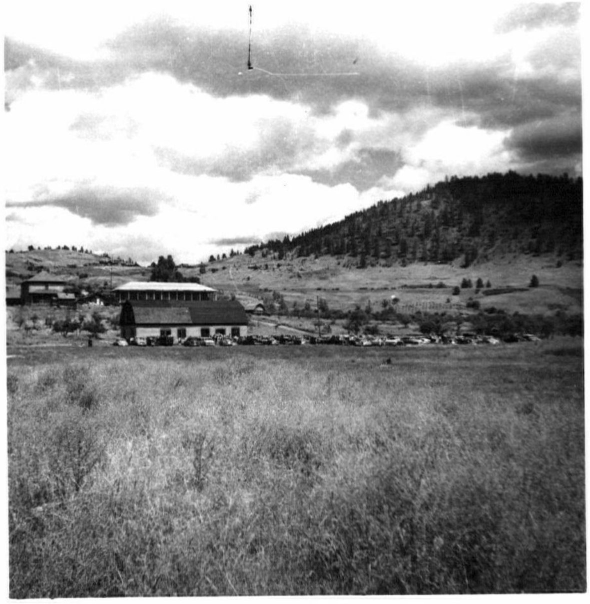
Claypit Series (Black silt loam and loam)

Included in this series are the very dark grey brown soils developed on medium to heavy textured sediments overlying lighter textured sediments. Two types, silt loam and loam were differentiated comprising 180 acres in all.

Claypit silt loam

This type covers 100 acres mostly in one piece along the back of a wide terrace in Lot 453. It occupies an area of basin relief with very gentle slopes as seen in Plate V. The type of formation suggests an abandoned river channel which the river occupied only at flood stage over a long period of years during which fine textured materials were deposited on top of earlier deposits of coarser materials. The fine materials accumulated in layers up to a depth of 15 feet or more. The texture of the parent material is clay to silty clay. Laboratory analysis of the surface sample taken showed

PLATE V



A. Claypit silt loam on level to very gently sloping topography in the foreground.

B. Claypit silt loam profile with one foot of dark colored surface soil. The top six inches is cultivated. At about five feet a fine sand strata appears.

the texture to be clay loam but the texture in the field ranges from a heavy loam through silt loam to clay loam and the type has been designated as silt loam.

The following profile was examined in a nearly level cultivated field.

A_{1c}x	0-6"	10YR 3/2* very dark grey brown (moist) 10YR 4/2 dark grey brown (dry) medium blocky to coarse platy clay loam; friable; slightly hard when dry; pH 5.8 Numerous worm and rodent burrows, fine feeding roots.
A_{12}	6-12"	10YR 3/2 dark grey brown (moist), 10YR 5/2 - 4/2 grey-brown (dry) moderate coarse blocky clay loam; friable, slightly hard when dry, pH 6.0. Many fine roots, burrows.
B_1	12-20"	10YR 3/4 very dark yellow brown (moist, 10YR 6/3 pale brown (dry) silty clay loam; strong medium blocky; hard when dry; pH 6.5. Numerous roots.
B_2	20-24"	2.5Y 4/4 olive brown (moist), 10YR 7/2 light grey (dry), strong medium blocky clay loam; very hard when dry; numerous roots, pH 8.0 effervescence with dilute acid.
C_1	24-54"	2.5Y 5/2 grey brown mottled with 5/4 light olive brown (wet); 2.5Y 7/2 light grey mottled with 6/2 light brownish grey clay; strong medium blocky with limey coating on aggregates; very hard when dry; sticky when wet. pH 8.0; strong effervescence with dilute acid.
C	54-60"	2.5Y 4/2 dark grey brown (moist), 10YR 6/2 light brown grey (dry), friable, compact, clay loam; weak fine blocky structure. pH 8.0, Strong effervescence.

D 60" plus 10YR 4/2 dark grey brown (moist), 10YR 7/2 light grey (dry) fine sand; friable, moderately compact, weak massive structure. pH 8.0 effervescence with acid.

x "C" denotes a cultivated horizon.

* Numbers are Munsell notations which express the precise quality of a color in terms of its components, hue, value and chroma (36).

The main variation within the type is the depth to the D horizon, which may range from two to fifteen feet.

Surface drainage is low in the basin areas and temporary ponding occurs in the spring in these depressions. Internal drainage is slow due to the moderately heavy-textured subsoil. This is evidenced by the mottling of color in the C_1 horizon indicating wet conditions for a good part of the year.

In the map area this type is all cleared, so that native vegetation must be inferred from similar situations elsewhere. These were observed to be sparse stands of yellow pine, with some Douglas fir growing in grassland environment.

In common with other soils of the Doukhobor lands, this type is being used to only a limited extent. Though good stands of alfalfa can be established and maintained, much of this land is in a semi-abandoned state. Weed infestation is very serious, such noxious plants as sow thistle, Russian thistle, knapweed and couch grass being prevalent; in some cases they constitute the entire crop. These weeds, with varying proportions of sweet-clover, vetch and tame grasses are regularly cut for hay.

Because of the local basin relief, summer frosts will likely be more common here than elsewhere on the terrace and it was noted, that tomatoes, beans and other sensitive crops are grown at higher elevations with better air drainage.

Claypit loam

In general the Claypit loam has the same position, land form and relief as the Claypit silt loam. It covers 80 acres, divided into two phases, level and sloping. The sloping phase is found on only 3 acres. The main area of this type is found along the margin of the silt loam. The loam could be regarded as a transition into the lighter soils near the river.

The profile described below was examined in a cultivated field where the depth to the D horizon was considered to be average.

A_{1c} 0-8" 10YR 3/2 very dark grey brown (moist), 10YR 4/2 - 4/3 dark brown (dry), friable heavy sandy loam; moderate coarse blocky structure; pH 6.5. Numerous roots.

A_{12} 8-15" 10YR 3/3 dark brown (moist), 10YR 4/3 dark brown (dry), friable loam, moderate coarse blocky. pH 7.0. Numerous roots.

B_1 15-20" 10YR 3/4 dark yellowish brown (wet), 10YR 5/3 brown (dry), friable loam, moderate coarse blocky; pH 7.5 Numerous roots.

B_2 30-40" 10YR 6/4 light yellowish brown (moist), 10YR 2/3 very pale brown (dry), very firm silty clay loam; slightly hard when dry; moderate medium blocky structure; pH 8.3, limy. Few roots.

D 40" plus 10YR 6/3 pale brown (dry), loose sand; single grain. pH 8.3; limy, Few roots.

The texture is lighter, internal drainage and aeration better and the consistence more friable than in the silt loam. These qualities are responsible for the better workability and the local farmers express a preference for this type for gardens because of its great ease of cultivation, and lack of tendency to bake after irrigation.

Surface drainage is comparable to that of the silt loam but internal drainage is more rapid than the loam type is formed on lighter, more porous material, underlain by bedded sands generally of a coarser nature.

Boundary Series (Black loam over sand and gravel)

This series includes very dark brown soils of medium texture developed on a thin veneer of slightly gravelly sediments overlying coarse, excessively drained sediments. In the map area only the loam type was classified.

Boundary loam

This series is widespread in the valley but on the Doukhobor land only 31 acres of it were found. It is formed on Kettle river terraces having very little relief.

An area containing some small kettles about ten feet in depth was mapped as a sloping phase. Only one acre of this phase lies within the community boundary.

The parent material is a layer of medium-textured alluvial sediments, normally about two feet in depth, laid unconformably on coarse sands and gravels. There is considerable variability in the depth to gravel and in the content of gravel in the solum.

The following profile, with an average depth of solum was examined in a cultivated field.

A_{1c} 0-14" Very dark brown granular to blocky, friable loam, containing some fine gravel, many roots. pH 6.25.

B 14-21" Brown medium blocky loam, friable, containing fine gravel. Many roots. pH 6.0.

D 21 plus Light grey stratified coarse sand and gravel; loose, single grain structure; no roots. Lime at 3 to 4 feet; pH 7.0.

The A_{1c} horizon is present only in local areas that have been cultivated and irrigated. In areas that are more nearly virgin the A horizon is shallower.

There are few stones though the gravel content of the surface soil is considerable in places.

Drainage through the gravelly substratum is rapid, though the permeability of the solum is satisfactory for furrow irrigation.

Native cover probably consisted of grassland with scattered yellow pine similar to that assumed for the Claypit soils.

The Boundary loam is all under cultivation and most of it is irrigated. Tree fruits, alfalfa, potatoes, garden crops and cereals are grown. It is an important soil type in the Covert Irrigation District west of the Danville customs port.

Carson Series (Black loamy sand and sandy loam)

Very dark grey brown soils developed on light textured terrace sediments comprise this series.

It embraces three soil types, sandy loam, coarse sandy loam and loamy sand, totalling 261 acres.

Carson loamy sand

Carson loamy sand is developed on level to gently sloping terraces flanking the Kettle and Granby rivers. The mapped areas amounting to 223 acres occur west of Grand Forks in the vicinity of Carsons Corner, and north of Grand Forks on dissected terraces above Ward's lake. A windblown phase accounts for 62 acres of this type. Further areas are believed to occur south of the Kettle river in the Grand Forks Irrigation District. Some of the terraces are quite extensive, ranging up to a mile or so in width. The elevations of the terraces examined range from 1700 to 1950 feet.

Relief is level or gently sloping. In the windblown phase microrelief is very uneven, many of the former dunes are too large to be economically levelled.

The topography is hummocky with dunes five to fifteen feet high and seventy five to one hundred yards across. At present these dunes are not actively shifting, having been generally stabilized by vegetation.

The general order of deposition of terraces is sand over gravel. This is the pattern here, though occasional lenses of silty texture are found at varying depths in exposures along terrace faces. Judging by their regular stratification these lenses of fine material probably were laid in temporary lakes.

The profile described below was examined in a formerly cultivated field, now in grass, near Carsons Corner.

A_1 0-14" 10YR 2/2 very dark brown (moist), 10YR 4/1 dark grey (dry), weak fine to coarse blocky/sand, medium soft, very friable, breaking readily into single grains; many roots. pH 6.0

B_1 14-24" 10YR 3/3 dark brown (moist), 10YR 5/3 brown (dry) sand; weak fine to coarse blocky; soft, very friable, breaking readily into single grains; many roots. pH 6.0

B_2 24-40" 10YR 4/4 dark yellow brown (moist), 10YR 5/4 - 6/4 yellowish brown (dry), weak massive to blocky sand, soft, very friable, breaking readily into single grains; many roots. pH 6.5

C_1 40-60" 10YR 4/2 dark grey brown (moist), 10YR 6/2 light brownish grey (dry) sand; loose, single grain; pH 8.0

C_2 20" plus 10YR 4/3 dark brown (moist), 10YR 6/3 pale brown (dry), sand; slight lime accumulation; pH 8.3

Free carbonate is found only in the finer textured strata and is not a regular feature of the sandy parent material from which the Carson Series is derived though a slight lime accumulation may occur beneath the solum.

The texture, determined by laboratory test was sand. However, some variation was found in the field and it has been classed as loamy sand.

The hummock tops have a shallower and lighter colored A_1 horizon due to erosion into the hollows where the top soil is somewhat deeper than the average level areas. It can thus be noted that there is less organic matter in the soil of the hummocks resulting in lower fertility and a lower moisture holding capacity. In a few very small areas about half a mile southwest of Wards lake extreme wind erosion has removed the solum and exposed the limy parent material.

Drainage of the profile is rapid. There is very little surface runoff; most of the surplus moisture reaches the river by percolation through the terraces. Small streams from higher elevations disappear in the porous terraces and reach the main drainage via their surface channels only when in flood.

The native vegetation has been destroyed entirely by cultivation or altered by over-grazing but had consisted of moderate to sparse stands of yellow pine with a grass undercover. Most of the type on the community land was formerly cultivated but is now largely abandoned with a small acreage used for cereals. Hay crops are harvested in wet seasons from a portion of the remainder. The forage consists chiefly of couch grass and other weeds but with some cultivated grasses.

Carson coarse sandy loam

The ten acres mapped as this type is properly a variation due to differences in parent material. It is found on a deposit consisting of mixed materials eroded from the Hardy and Carson Series and deposited on a terrace belonging to the Danville Series. Failure of the storage dam at the north side of L. 453 resulted in the rapid erosion and mixing of materials and their deposit on the lower terrace as the released water made its way to the Kettle River by way of the most natural route.

Topography of this type is level to very gently sloping.

The profile was examined at several sites in fields under cultivation and irrigation. The A-horizon is dark grey brown, friable, coarse sandy loam containing varying amounts of gravel to a depth of six inches. The second horizon, from six to eighteen inches, is very compact brown coarse sandy-loam. Its hardness might be due to mechanical compaction, or possibly to its particle size distribution. Below a depth of 18 inches the material is loose, brown, coarse sandy loam, underlaid by coarse sand and gravel at depth.

The compact layer restricts the downward movement of water and makes possible the conveyance of water in ditches. This characteristic has been recognized by the Doukhobors, who are irrigating the type from the Kettle river. Water is pumped by electrically powered pumps to the high point on the plot to be irrigated. From there it is spread in ditches and furrows down the natural slope, which is very gentle.

Carson coarse sandy loam is all under cultivation, devoted to gardens, fruit trees and alfalfa in small plots.

Carson sandy loam

An area of 28 acres, on a low terrace of the Kettle river was mapped as Carson sandy loam. Part of the same terrace is Carson loamy sand. The sandy loam surface strata is laid on deep sandy deposits, similar to those from which the loamy sand is derived.

This profile was described in a cultivated field.

A_{1c}	0-8"	10YR 2/2 very dark brown (moist), 10YR 5/2 grey brown (dry) sandy loam; moderate coarse blocky, very friable, many fine roots. pH 6.4
B_1	8-21"	10YR 3/3 dark brown (moist), 10YR 5/2-5/3 grey brown (dry) sandy loam; moderate coarse blocky, very friable many roots. pH 6.9

B_2 21-44" 10YR 4/2-3/2 dark grey brown (moist), 10YR 6/3 pale brown (dry) sandy loam; weak coarse blocky, very friable, some roots. pH 7.8

D 44" plus 10YR 4/2 - 5/2 dark grey brown (moist) 10YR 6/2 light brown grey (dry) sand; single grained, loose, no roots. pH 7.2

The importance of the finer texture is in better moisture-holding capacity, and a greater ability to carry water in ditches. Consequently the type is all under cultivation, devoted to forage crops and gardens. In early summer, at the peak of the freshet, drainage in parts of the type is affected by high water. Subirrigation is limited to a brief period, however, and the moisture from this source does not sustain optimum growth later in the season. Because of its position within fifteen to twenty feet of river level, the area of the type mapped on community lands can be irrigated readily by pumping from the Kettle river.

Danville Series (Very dark brown gravelly loamy sand)

This series contains very dark brown soils derived from coarse textured and gravelly stony terraces. Only one type, loamy coarse sand, was differentiated in the map area.

Danville loamy coarse sand

This soil type occurs widely to the west and north of the city of Grand Forks. Besides the 193 acres classified on the communities there is a large area of this immediately adjacent to them. A typical area is the broad terrace on which the airport is located.

The relief is typically level to very gently sloping, though kettles are found on the upper terraces. These are of infrequent occurrence and are shown on the map as miscellaneous eroded areas.

The profiles examined are very permeable though finer-textured strata are observed on some terrace faces. At one place erosion of the parent gravel has exposed a band of fine-textured material which outcrops along a gentle slope, forming the division between two adjoining gravelly terraces, one ten feet higher than the other. The exposed section is fifty feet wide and extends along the terrace face a distance of 1,000 feet. While the finer stratum presumably underlies the gravel on the upper terrace at a depth of less than ten feet, it appears to have no effect on moisture relations as no differences in the growth of plants were noted, though growth is much more abundant on the exposure of fine material itself. The terraces are composed of stratified sands and gravels, the larger particles of which are well rounded. Kettles found on the higher terraces (1,950' elevation) at extremities of this type indicate the material was laid down by meltwater of retreating glaciers at the close of the last glacial period.

In parts of this type surface deposits of sand vary from a few inches to two feet. Other areas which are quite extensive have the gravelly loamy sand material right at the surface. From the point of view of land use it was not deemed worth while to separate these areas. Therefore within this type areas may be found that contain up to 25 percent gravel at the surface.

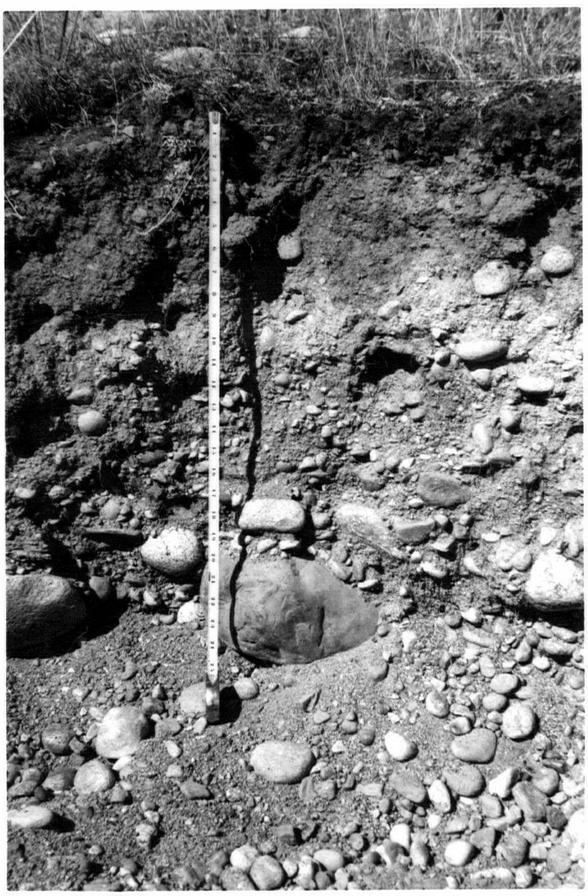
The surface A and B horizons are shallower where there is a high percentage of gravel. Generally the gravelly surface is found more frequently along the outer edge of the terrace.

The following profile description represents the average condition on formerly cultivated land now used for grazing as shown in Plate VI.

A_1	0-12"	10YR 2/2 very dark brown (moist), 10YR 4/2 dark grey brown (dry), friable loamy coarse sand containing some gravel; blocky structure; many feeding roots; pH 6.0
B_1	12-17"	10YR 3/3 dark brown (moist), 10YR 5/4 yellow brown (dry), friable loamy coarse sand containing some gravel; weak fine blocky structure; many roots; pH 6.5
B_2	17-23"	10YR 2/4 dark yellow brown (moist),

PLATE VI

A. Danville loamy coarse sand with level topography.



B. Danville loamy coarse sand showing shallow surface horizon and gravelly, cobbly subsoil.

10YR 6/4 light yellow brown (dry), loose gravel and coarse sand; single grain structure; many roots; pH 6.8

C 23" plus 10YR 6/3 pale brown (moist), 10YR 6/4 light yellow brown (dry), loose, coarse sand and gravel; single grain structure pH 7.0

The B horizon is weakly developed and the boundary with the C horizon is indistinct.

Although a few cobbles are present in the upper horizons, stoniness does not appear to be a limiting factor in the use of these soils.

All of this type is excessively drained internally and water losses take place due to deep percolation.

One small area, less than one half acre, is affected by wind erosion. This is classified as a dune with the miscellaneous areas as it is subject to continual shifting. Variations in the depth to gravel in profiles cannot be attributed to erosion; they are due to differences in the original deposition of the parent materials.

Native vegetation on uncleared parts of the terraces consists of scattered yellow pine with grassy undercover. Most of the type has been cultivated and abandoned. It now supports early maturing spear grasses and downy brome with assorted annual and perennial weeds. In the present condition the vegetation is suitable only for spring and early summer grazing because it matures by the end of June. Under cultivation, the type was devoted mainly to the production of cereals.

The Granby Series (Brown Podzolic loamy sand to silt loam)

This series embraces only 32 acres of three soil types, sandy loam, silt loam and loamy sand. All three types occur as small terraces from ten to forty or fifty feet above low water along the Granby and Kettle rivers. They are included in one series because of their common origin and the small acreage.

Granby sandy loam

This is the most important type in the series, occupying 17 acres on two small benches at Caesar and Gilpin. As the intermediate type between the silt loam and loamy sand it probably best represents the series as to soil profile characteristics.

The relief is flat, or nearly so, and the parent material is underlain by bedded fine sands. This is the same material that underlies the silt loam as a D horizon at Gilpin.

The following profile description was taken from a representative site near Caesar.

A 0-2" 10YR 5/3 brown (dry) sandy loam; medium fine granular; numerous roots; pH 7.5

B 2-18" 10YR 6/2 light brown grey sandy loam; medium massive; hard; numerous roots; pH 6.0

C 18" plus Light yellow brown fine sand; single grain; loose; soft; pH 6.5

There is considerable variation in profiles due to differences in the parent materials. Development of the profile is weak and the character of the parent material dominates other soil characteristics.

In general this type is stone free and internal drainage is moderate to excessive.

The type is all cleared and under cultivation; the portion at Gilpin is divided into small plots for irrigated gardens and homesites, while the part at Caesar is devoted to growing cereals without irrigation. The native vegetation consisted of Douglas fir and cottonwood, and possibly yellow pine on the driest locations.

The sandy loam is well adapted to intensive use with irrigation. Poor to moderate yields of cereals or hay can be expected without irrigation.

Granby silt loam

Found on a terrace at Gilpin covering 3 acres, it is well drained, lying fifty feet above the Kettle river.

The parent material consists of six feet of bedded silty material over sand. Gravel occurs at a depth of ten feet.

The surface texture is silt loam which is friable when moist, hard when dry. Free carbonate occurs in the B_2 horizon.

The present use of this small area is for gardens, irrigated from the Kettle river by pumping. The subsoil supplies the local requirements of "clay" for making plaster.

Granby loamy sand

This type covers 12 acres of a low terrace of the Granby river in the community of Caesar. The terrace, shaped like a peninsula, is about 15 feet above low water, and while not ordinarily subject to flooding, drainage is markedly affected by high water. This is evidenced by strong mottling in the lower B horizon. The profile is variable due to variations in the parent material and micro-relief and old channels two or three feet deep produce an uneven surface. The ridges are sandy and the hollows are heavier textured. The parent material is similar to that of the Granby sandy loam though the surface material, and in some cases the deeper layers as well, are coarser in texture.

Characteristics of the upper horizons are similar to those of the sandy loam type, however the B horizon is compact and massive due to iron cementation resulting from a high water table. For this reason it should not properly be classed as a Brown Podzolic soil but rather be placed in a different category were the acreage large enough to warrant a separation.

Stones and gravel are not abundant but the depth to gravel is not more than ten feet. Gravel was noted outcropping at the surface in one location.

Stream bank erosion is a serious problem. The river is gradually cutting into the peninsula and threatens to cut it off if it continues to shift in its present direction.

Judging by the trees growing along the river banks willows and cottonwood were the native vegetation, although the mapped portion of the type is all under cultivation, devoted mainly to cereal production. Farmers report that alfalfa stands cannot be maintained and it is possible that the high spring water interferes with the deep rooting habit, and gives the advantage to shallower rooting plants.

Caesar Series (Brown Podzolic sands)

The series occupies 118 acres of sandy deposits laid over glacial terraces on the Doukhobor communities. It occupies a much larger area outside the communities along the Granby river north of Grand Forks. Two types were separated, loamy coarse sand and fine sand.

Caesar loamy coarse sand

The relief on this type is very irregular. Kettles with slopes up to 30 percent are common and some of the larger holes are 50 feet deep and although there are areas of gentle slopes they were not considered to be of sufficient extent or importance to justify separating. The total area mapped is 100 acres.

This type is developed on deposits of coarse sand. Deeper strata contain gravel and stones which increase in number and size with depth. The till which underlies parts of the series has no apparent influence on soil formation.

The following description is a profile examined on a gently sloping portion of a rolling, deeply kettled terrace, under a sparse cover of immature white pine, lodgepole pine and Douglas fir about 6" in diameter with grass undercover.

A_0	½-0"	Leaves and twigs recently fallen. Little tendency to accumulate.
A_1	0-1"	10YR 3/2 very dark grey (moist) 10YR 4/2 dark grey brown (dry), loamy coarse sand; weak fine blocky structure; very friable; many roots; pH 7.0
A_2		Present or absent, a very thin light grey layer.
B_1	1-6"	10YR 4/3 dark brown (moist) 10YR 6/3 pale brown (dry), loamy coarse sand; weak coarse blocky; friable, many roots; pH 6.0

B_2 6-16" 10YR 4/3 dark brown (moist) 10YR 6/3 pale brown (dry); moderate coarse blocky loamy coarse sand; slightly hard; numerous roots; pH 7.0

C_1 16-20" 10YR 4/3 dark brown (moist) 10YR 6/3 pale brown (dry) coarse sand; moderate massive; friable, few roots; pH 7.0

C 20 " plus 10YR 5/4 yellow brown (moist), 10YR 6/4 light yellow brown (dry), coarse sand; single grain; loose; pH 7.0

Where cleared and in grass for many years a dark surface horizon up to 9 inches deep has developed. Grassland is not likely to persist and the areas which were formerly cultivated, if allowed to remain idle may eventually revert to forest growth.

Natural drainage of the soil profile is excessive. Surface drainage is rapid also except in depressional areas receiving runoff from surrounding land. None of the kettles contain permanent ponds, which would indicate that their drainage is accomplished by porous materials beneath.

Once all forested, the cleared portions are now devoted chiefly to grazing. Only a few acres in a kettle on the community of Caesar remain in cultivation and the yields are poor.

Caesar fine sand

This series is derived from a shallow deposit of fine sand and 18 acres was mapped on the Doukhobor lands. Many smaller deposits of similar sorted materials are found adjacent to the map area and it was noted that the smaller these are in area the finer their texture.

Cleared and cultivated at one time, this type has long been abandoned. If left, it eventually will return to forest though regrowth is slow.

Internal drainage on this type is moderate to excessive. It is too dry to be cultivated without irrigation and the excessively drained profile is not ideal for furrow irrigation.

The best use for this land at the present time is grazing or forestry.

Soils Derived from Glacial Till and Till Derivatives

Semi-consolidated till laid down by a former ice sheet (30) constitutes the parent material for most of these soils. However, partially water worked and kettled materials, derived from the till, are included.

The till covers a wide range of land forms from mountainous uplands to terrace-like moraines. The mountainous areas consists of rock promontories rising 1,500 feet above the valleys. They have been rounded by erosion and glaciation and covered by a thin mantle of till that leaves many jagged rocks exposed.

The valley walls and mountainsides have precipitous slopes. The glacial mantle deepens towards the valley bottom and merges with the morainal deposits of valley glaciers. At some places end moraines are found 300 feet up the valley wall.

The Hardy Series (Black loam and sandy loam)

The series comprises four types, loam, gravelly loam, gravelly sandy loam and stony loam, with some variation in characteristics depending on the conditions of deposition of the parent till. The total area of the series as measured from the map sheets is 2,373 acres. The distribution is over all the south facing slopes in the main Kettle valley, the easterly slope above Ward's lake, and extending well up onto the plateau to the west.

Hardy loam

Two phases of this type were mapped, a level and a sloping phase. The former amounts to 17 acres and the latter 197 acres.

This type is stone and gravel free at the bottom of the slope, but becomes slightly gravelly along the upper margin where it contacts the Hardy gravelly loam.

This type lies in a transition area between Hardy gravelly loam and Claypit silt loam. The small amount of gravel in the profile and a somewhat heavier texture as well as the absence of stones makes

PLATE VII

Slope beyond buildings illustrates the topography of the Hardy series. The Hardy loam, sloping phase grades into Hardy gravelly loam, moderately steep phase followed by the steeper slopes of the Hardy stony loam which covers the hill-top. Foreground is Claypit series.

it more desirable agriculturally.

The Hardy loam is made up largely of fine materials eroded off of the Hardy gravelly loam. This eroded material has been deposited partly on glacial till and partly on clay loam alluvium. The lower parts of the sloping phase and much of the level phase of Hardy loam is underlain by the clay loam alluvium which forms a D-horizon.

The profile description given below was taken in an alfalfa field on an 8 percent slope in the sloping phase.

A_{1c}	0-12"	10YR 2/2 very dark brown (moist) 10YR 3/2 - 4/2 very dark grey brown (dry) loam; weak coarse blocky, very friable, numerous roots, small amount of fine gravel pH 6.8
A_{12}	12-28"	10YR 3/2 very dark brown (moist) 10YR 4/2 - 3/2 dark grey brown (dry) loam; weak coarse blocky very friable, numerous roots, small amount of fine gravel. pH 7.0
B_1	28-38"	10YR 3/4 - 4/3 dark yellow brown (moist) 10YR 5/3 brown (dry) loam; weak coarse blocky, very friable, roots, slight effervescence with acid. pH 7.5
D	38" plus	10YR 4/3 - 3/3 brown (moist) 10YR 6/3 pale brown (dry) clay loam; strong coarse blocky, hard, few roots, slight effervescence with acid. pH 7.7

Surface drainage is good and internal drainage moderate. Very few stones occur on this type.

Originally grassland with scattered yellow pine and fir, it has all been cleared of trees and stones and brought under cultivation. It was originally planted to orchard but because of inadequate water and other factors the orchards did not produce satisfactorily and are now decadent and produce no fruit of value. Most of the type, including the spaces between rows of trees, is now devoted to forage production. Crops consist of grasses and legumes and usually a high proportion of weeds.

Hardy gravelly loam

The gravelly loam type consists of two phases, a sloping phase (23 acres) and a moderately steep phase (513 acres). It occupies the upper parts of the arable slopes of the valley walls, and extends in a band around the base of the south and east sides of Hardy mountain.

The profile described below was examined in a cultivated field on a 10 percent slope.

A_{1c}	0-8"	2.5Y 2/0 black (moist), 10YR 3/1 very dark grey (dry) gravelly sandy loam; extremely friable; very weak fine blocky to single grained structure. Very many roots. Some rounded and angular cobbles. pH 7.0
A_{12}	8-25"	2.5Y 2/0 black (moist), 10YR 3/2 very dark grey brown. pH 6.8. Other characteristics as above.
A_3	25-34"	10YR 2/2 very dark brown (moist),

		10YR 3/3 dark brown (dry) gravelly sandy loam; very friable, weak fine blocky. Numerous roots. Some rounded and angular cobbles. pH 6.9
B_1	34-50"	10YR 3/4 dark yellow brown (moist), 10YR 5/3 - 4/3 brown (dry) gravelly sandy loam; friable, weak fine blocky, some roots, some rounded and angular cobbles. pH 6.9
B_2	50-64"	10YR 5/3 brown (moist) 10YR 6/3 pale brown (dry) gravelly sandy loam; hard, moderate medium blocky, few roots, some rounded and angular cobbles. pH 7.0
C_1	64-100"	2.5Y 5/2 - 4/2 grey brown, 10YR 7/2 - 6/2 light grey (dry) gravelly sandy loam; extremely hard, strong coarse blocky, lime cemented, strong effervescence with acid, no roots, some rounded and angular cobbles. pH 8.0
C	100" plus	2.5Y 5/2 grey brown (moist) 10YR 7/2 light grey (dry) gravelly sandy loam; strongly lime cemented pH 8.1. Other characteristics as above.

Although the mechanical analysis of the soil showed it to be a sandy loam, tending toward loam, it has been designated as loam on the basis of numerous field tests. The gravel content will vary from 30 to 40 percent in the subsoil, and will vary over a wider range in the surface depending on the effect of erosion.

The A horizon varies in depth from 12 to 36 inches with the extremes of drainage position, and where erosion has been severe surface horizons shallower than one foot are found. Depth to the free lime also varies greatly with drainage position.

All the steeper slopes were originally moderately stony and were covered with sub-angular fragments up to ten inches or more in diameter. The stones have been removed to a depth of six inches in the cultivated areas which now contain many stone piles.

Surface drainage is quite adequate on all phases of the gravelly loam type.

Vegetation is similar to that found on the loam and much of the area is used for community grazing. A few small fields are cultivated and irrigated from seepage from Hardy mountain.

Hardy gravelly sandy loam

There are 74 acres in the type, located on rough terraces which consist of partly-sorted till and accumulations of outwash products from the melting glacier which occupied the valley of July creek at the end of the ice age. Some of the terraces or moraines are quite smooth while others are deeply kettled and kettle phases comprise 17 and 57 acres respectively. The former may be seen in Plate VIII.

The parent material is seen to be roughly stratified in places. The content of gravel and sand is higher than in the till as a result of sorting and the removal of fine material by water. Two

PLATE VIII

A. Hardy gravelly sandy loam, kettle phase, is not well suited to cultivation. Abandoned orchard in foreground.

B. Hardy gravelly sandy loam. Note A_1-horizon reduced to six inches by erosion. Parent material has been partially worked by water though there is no distinct stratification.

prominent deposits, one of gravel, the other sand, were noted along the highway at what has been referred to as Spencer Hill in Lot 1027. They are the result of water sorting along the margins of valley glaciers. Surface sorting of the till is fairly common in this situation.

The type is mostly cleared and in abandoned orchard. There is no commercial production of fruit and the principal use made of the land is grazing.

Hardy stony loam (undifferentiated)

Included in this type are 1,549 acres of mountain and upland plateau. The major part of the Hardy stony loam is lithosolic soils and rock outcrops many of which lie on steep slopes but within this type there is also many areas of Hardy loam, gravelly loam, and gravelly sandy loam that are too small and isolated to map separately.

Mixed native grasses make up most of the cover. Small non-stony portions with less than 25 percent slope were formerly under cultivation. The fields occupied small depressions frequently less than one-half acre in extent. Many of the plots were planted to grass, and hay crops are still harvested from a few of them; others are abandoned and are covered with weeds. Attempts at cultivation were never sound, and the land would have been better used if it had been left as range. On the stony and steep portions there was a moderate cover of grasses except on some areas where stock had grazed intensively.

Gibbs Series (Brown Podzolic gravelly loam and sandy loam)

The Gibbs Series is developed on similar parent material to the Hardy Series but the Hardy Series is developed under grassland vegetation while the Gibbs soil is developed under a forest cover. Total area of this series is 1,515 acres, with three types, gravelly loam, gravelly sandy loam and stony loam undifferentiated.

It is found on a variety of rough terrain on forested plateaus, on steeply sloping mountain sides and valley walls and on the terrace like remnants left by valley glaciers.

The parent material is glacial till, in places somewhat altered by glacial meltwater and sorting is the main factor responsible for the occurrence of different soil types in the series.

Gibbs gravelly loam

The 102 acres classified in this type include the best of the cultivated and formerly cultivated lands along July creek. Most of the area has strong relief with slopes up to 25 percent. Stones are few to numerous and have been removed from most of the cultivated areas.

The profile described below was examined under forest cover of fir predominantly with choke-cherry, oregon grape, snowberry and some pine grass as undercover.

A_o	3-0"	Leaves and twigs partially decomposed in the upper part and well decomposed in the lower part. Dark colored and moist.
A_1	incipient	Barely recognizable as a thin veneer of mineral on the bottom of the A_0. Very dark brown. High in organic matter.
A_2	0-1/8"	10YR 7/1 - 6/1 grey (moist) 10YR 7/1 light grey (dry) loamy sand, soft. pH 6.5 Absent in many places. Best developed under old logs or decayed wood.
B_1	1/8-12"	10YR 3/3 dark brown (moist), 10YR 5/3 - 4/3 brown (dry) gravelly sandy loam; weak very fine blocky, extremely friable, very many fine feeding roots, small amount of rounded and angular cobbles. pH 6.9
B_2	12-27"	10YR 3/4 dark yellow brown (moist) 10YR 5/4 - 5/6 yellow brown (dry) gravelly sandy loam; weak fine blocky, very friable, fine feeding roots, cobbles as above. pH 6.3.
C_1	27-48"	10YR 3/4 - 4/4 dark yellow brown (moist) 10YR 5/4 yellow brown (dry) gravelly sandy loam; moderate blocky, firm, very few roots, cobbles as above. Very slight effervescence with acid. pH 7.9
C	48" plus	10YR 4/2 dark grey brown (moist) 10YR 6/2 - 7/2 pale brown (dry) gravelly sandy loam, lime cemented, extremely hard, cobbles as above, effervescence with acid. pH 8.0

Although the mechanical analysis of the soil showed it to be a sandy loam, tending toward a loam it has been designated as loam on the basis of field tests. Gravel is found in local areas and the variability in the parent material due to sorting is marked.

Internal drainage on this type is only moderate since most of it is underlain by compact glacial till. The surface drainage varies with the topography but generally is quite adequate.

The native vegetation consisted of fir, white and lodgepole pine, and larch. The present cover is grass with the forest encroachment on the areas that have been abandoned. It is used almost exclusively for grazing.

Gibbs gravelly sandy loam

Along the lower part of July creek and the Kettle river 45 acres of a sloping phase and 88 acres of a kettle phase were mapped on the moraines of valley glaciers. Most of the sloping phase has been irrigated for the production of garden and forage crops. It occupies small patches in larger areas of soil which are not suitable for cultivation.

In the kettle phase depressions vary from 10 to approximately 30 feet in depth and may be situated as close as 100 yards apart. Size and occurence, though, is quite variable.

Stoniness is variable, the cultivated areas having been cleared of stones. Internal drainage is moderate where till underlies the solum and more rapid where water worked materials have been deposited. The fact that no ponds were found in the kettles indicates that water must percolate readily through a porous substratum.

Gibbs stony loam (undifferentiated)

This type, embracing 1,280 acres on the Doukhobor lands, includes all the forested areas of till on mountainous topography together with some formerly cultivated fields with slopes from 25 to 45 percent or more. It is generally stony with hilly topography.

The stony loam is devoted to forestry or grazing. The forested portions produce poles, posts and fuel for the communities. The native vegetation is similar to that found on the gravelly loam type.

The commercial timber crop has been harvested long ago and parts of the type were once cleared for cultivation. The cultivated areas have been abandoned and are now used for grazing although the forest is now encroaching on them. Much of the forest land has been over cut to supply local demands for wood, leaving a scanty growth of herbaceous and woody plants that have some value for grazing. The present production of forest products is very low and for maximum future production grazing should not be permitted.

Soils Derived from Alluvial Fans

The alluvial fans are commonly found along the base of steep valley walls where a stream enters the main valley. The fan is built because the gradient of the entering stream suddenly decreases so it cannot carry its original load. The gradient is steep near the apex which is usually very bouldry. Below the apex the gradient lessens and finer textured material is deposited. While building a fan a stream will change position many times so that the fans surface will be characterized by a network of braided channels (30).

Rideau Complex (Brown Podzolic alluvial fans)

The total area included in the Rideau complex is 18 acres. It occurs at the community of Gilpin, along the base of the mountain slope where it meets the river terrace as a sloping wedge of soil composed of numerous coalescing fans washed down from the bench above by erosion. The material is of a mixed nature varying according to the steepness of the slope above and the part played by running water in transporting the parent materials.

The upper side of the slope or fans consists of coarse materials including stones and boulders; the larger the fan and the higher up the slope, the larger the fragments encountered. The lower part of the fans are made up of the finer materials washed from above and resemble the fine alluvium of the terraces in mechanical composition.

The slopes on the arable portions of the fans are usually less than 10 percent. Slope is not critical as the areas are very small, and irrigation furrows correspondingly short.

The parent material is the dominant characteristic of the soil and no profile description could adequately describe the complex. The textures are mainly sandy loam to loamy sand with variable inclusions of gravel, stones and boulders. In some cases gravel may occur within 16 inches of the surface.

The following is a description of a profile examined on the lower part of one of the smaller fans in a formerly cultivated area.

A	0-3"	Brown loamy sand; weak crumb structure; loose, friable; many roots.
B_1	3-12"	Pale brown loamy sand; weak, coarse blocky; friable; numerous roots.
B_2	12-24"	Very pale brown loamy sand; medium massive; firm; few roots.
C	24" plus	Pale brown sand; single grain; loose, porous.

Internal drainage is quite variable depending mainly on the arrangement of underlying strata. This is an important factor in the use of the complex. Most of the type has, or has had some stones and the range is from occasional stones to numerous stones.

The type is mostly devoted to gardens under irrigation with small areas left idle or grazed. The part which is not cultivated supports a few yellow pine and fir trees, enough to provide shade for grazing livestock and grasses and some shrubs form the ground cover.

Miscellaneous Soils

Bottomland

These are immature soils found on recent alluvial deposits. They are not described as separate zonal series because of their limited extent, only 7 acres, on the Doukhobor lands. They are found on the west side of the Granby River in Lot 2017 at Caesar.

Most of the bottomlands on the community were acquired by Granby Mining and Smelting Company as part of a reservoir site. Though not actually part of Smelter lake, flooding along the river in this locality was aggravated by raising the water level downstream. The dam controlling the level of the Smelter lake reservoir has been removed and the lake drained but the bottoms, even since the draining of the lake, are subject to frequent flooding, and when examined at low water the river was only about ten feet below its banks.

The topography is characterized by numerous shallow channels and the parent materials are fine sands over well sorted gravel at five to ten feet.

These bottomland soils are associated with soils of the Brown Podzolic group and themselves show some development. In the well wooded sections A_2 horizons up to one inch in thickness were noted. A weakly developed brown B horizon may be present above the yellow brown sandy parent material which is iron stained by the fluctuating water table. However, this development is very slight and in some cases is obscured by fresh deposition.

The cover on the bottom lands is variable. The portions where flooding is frequent and prolonged have only coarse grasses and reeds growing on them. Where flooding is of short duration, cottonwood is the dominant growth.

The bottoms might have a value for pasture if cleared, but clearing is not recommended in the face of the apparent flood hazard and they are suited to growing forest products.

Saline Seepage Soils

These areas make up 103 acres on the community lands. They are associated with several soil series and are found on both glacial and alluvial materials in scattered locations along the valley of July creek and in the portion of the Grand Forks area locally called Christovoye overlooking the Granby river. The total area is made up of many small seepages often less than an acre in extent.

Topography is variable. Some of the areas are depressional; others are located around sidehill springs where a trickle of limy water keeps the ground saturated much of the time. Relief and topography are not a deciding factor in the use of the soil; most of the areas can be cultivated for some purpose though their uses might be limited. Slopes, however, will range from 0 to 25 percent.

All profiles examined in these areas showed lime accumulation to the surface. The parent material varies widely from heavy loam to gravelly sand with many cobbles. The majority of the ~~areas~~ soils though have developed on a medium textured alluvium.

The following profile description which was taken in a pasture on a 10 percent slope may be considered average for the type. Groundwater in the late summer was below ten feet.

0 - 18" 10YR 2/2 very dark brown (moist)
10YR 4/2 dark grey brown (dry) loam; weak medium blocky, very friable, numerous

	fine grass roots strong effervescence with acid. pH 8.1
18-30"	10YR 6/2 light brown grey (moist) 10YR 7)2 light grey (dry) loam; strong coarse blocky, very hard, very strongly lime cemented, very few grass roots, strong effervescence pH 8.0
30-36"	10YR 6/3 pale brown (moist) 10YR 8/2 - 7/2 white (dry) loam; strong coarse blocky, very hard, very strongly lime cemented, no roots, strong effervescence. pH 8.1
36-44"	10YR 6/3 pale brown (moist) 10YR 7/2 light grey (dry) loam; massive, very hard, strongly lime cemented, strong effervescence. pH 8.0
44" plus	2.5Y 5/4 - 5/2 light olive brown (moist) 2.5Y 7/2 - 8/2 light grey (dry) loam; massive, very hard, strongly lime cemented, strong effervescence pH. 8.3

Poor drainage is the factor which dominates the development of these soils. Local rock formations contain outcrops of limestone and drainage waters flowing over these formations become charged with lime. When a situation arises where an area is kept saturated with these waters the saline condition developes by accumulation of the limy residues. Some of the limy areas occur on alluvial materials along small streams where the surface is kept moist by natural sub-irrigation and occasional flooding. Others occur on glacial deposits having impeded drainage. These frequently are located on sloping ground where a spring supplies just enough water to keep the surface layers of soil moist.

The compact, impermeable subsoil prevents the downward percolation of water and the removal of salts to deeper strata.

Hay and pasture crops constitute the major production from scattered areas of this group, though small portions are also used for gardens. In these cases the availability of water outweighs the adverse affects of the lime accumulations. Generally the water supply to these areas also contains lime so that it could not be used to leach excess lime from the soil. However, if the soil can be kept quite moist with an adequate supply of water there is less chance of plant growth being inhibited by increasing salt concentration as the soil dries out.

Eroded and Dissected Lands

This group includes all steep terrace faces and deep eroded gulleys, most of which are situated between the different terrace levels. It is wasteland or land of little productive value. The total area involved on the community lands in Grand Forks area is 244 acres.

At present not all of the slopes are actively eroding as many are stabilized with trees and shrubs. All vegetation on these slopes should be left and if possible more growth encouraged on the barren areas as grazing or logging would lead to erosion and cause loss of soil from the upper terraces and deposit debris on the lower terraces.

Rough Mountainous Lands

In Grand Forks area 244 acres of this type are mapped. Rock outcrops, areas too steep and rocky to be cultivated and mountainous lands lying on the outskirts of most of the Community lands are included in this group. These lands are of no value for cultivation but may be used in a limited way for grazing or forestry. On the community lands however, many of these areas have been over cut and the small regrowth supplies only fuel, posts and poles. In the more populous communities they do not even supply these needs.

Very small patches of arable soil may occur in the rough mountainous lands.

WEST KOOTENAY AREA

The soils of the West Kootenay area were classified and mapped into three groups, soils derived from alluvium, soils derived from alluvial fans and miscellaneous soils. The soil types mapped in these groups amount to 13,545 acres and are listed by communities with their respective acreages in TABLE 22.

Soils Derived from Alluvium.

Five series of soils totalling 6,351 acres were described on alluvial material in the West Kootenay area. A typical example of this material is shown in Plate IX.

Shoreacres Series (Brown Podzolic silt loam to fine sandy loam)

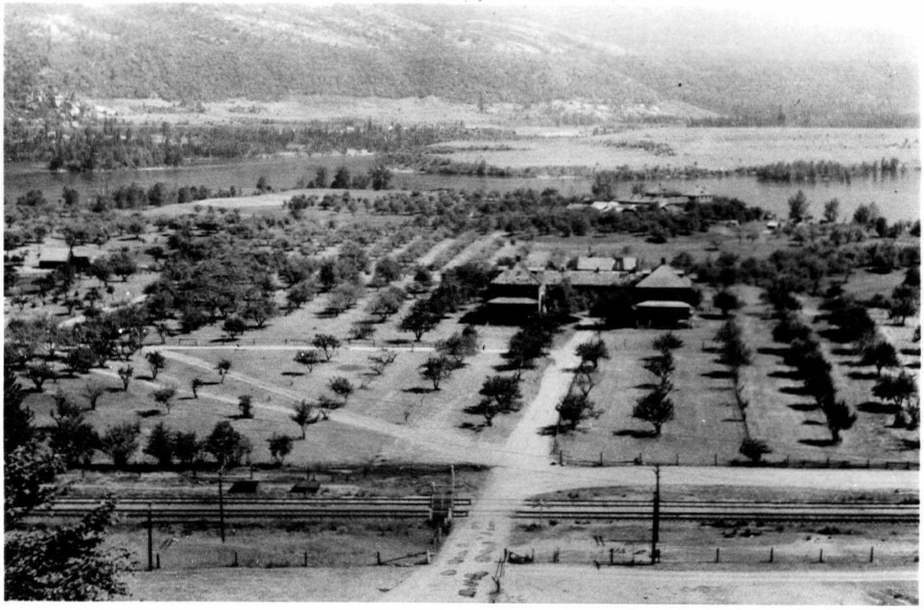
Two types, totalling 939 acres, were mapped in the series; Shoreacres silt loam (414 acres) and Shoreacrea fine sandy loam (453 acres). Areas of silt loam are found at Raspberry, Glade, Pass Creek and Krestova. The main areas of fine sandy loam are located at Brilliant, Raspberry, Shoreacres and Krestova.

These soils occur on glacial river terraces ranging from 20 to 500 feet above present river level.

Shoreacres silt loam

This soil has developed on very fine textured alluvium such as silt loam and clays that were

PLATE IX



Shoreacres fine sandy loam showing typical landscape in the West Kootenay area where terraces rise stepwise from the valley bottoms. Along the mountain can be seen the stumped and eroded kame terraces (Krestova series). Fans extend from the erosion gullies over the terrace deposits.

deposited in quiet water. In many places a thin layer of coarser textured material has been laid on the surface to give a texture in the surface horizons of fine sandy loam or loam. The topography is nearly level.

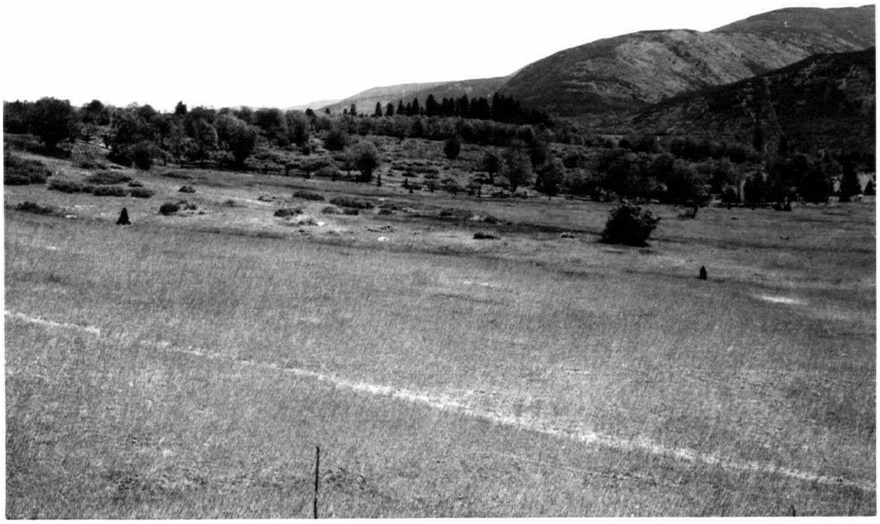
The profile description given below is from a site located in a pasture. The site and profile are shown in Plate X.

A_{1c}	0-5"	10YR 3/4 dark yellow brown (moist) 10YR 5/3 - 5/4 brown (dry) loam; weak coarse blocky, very friable, very many fine feeding roots. pH 6.0
A_{12}	5-9"	10YR 4/2 dark grey brown (moist) 10YR 6/3 - 6/2 pale brown (dry) loam; moderate coarse platy to blocky, firm, numerous roots. pH 5.7
B_1	9-12"	2.5Y 4/2 dark grey brown (moist), 2.5Y 5/2 - 6/2 grey brown (dry) clay; moderate medium blocky, very hard, fine feeding roots. pH 5.7
B_2	12-32"	2.5Y 5/2 - 4/2 very dark grey brown (moist), 2.5Y 6/2 light brown grey (dry) clay; moderate medium blocky hard, few roots. pH 5.6
C	32" plus	5Y 4/2 - 3/2 olive grey (moist), 5Y 6/2 - 6/1 light olive grey (dry) heavy clay; moderate medium blocky, hard, no roots. pH 5.8

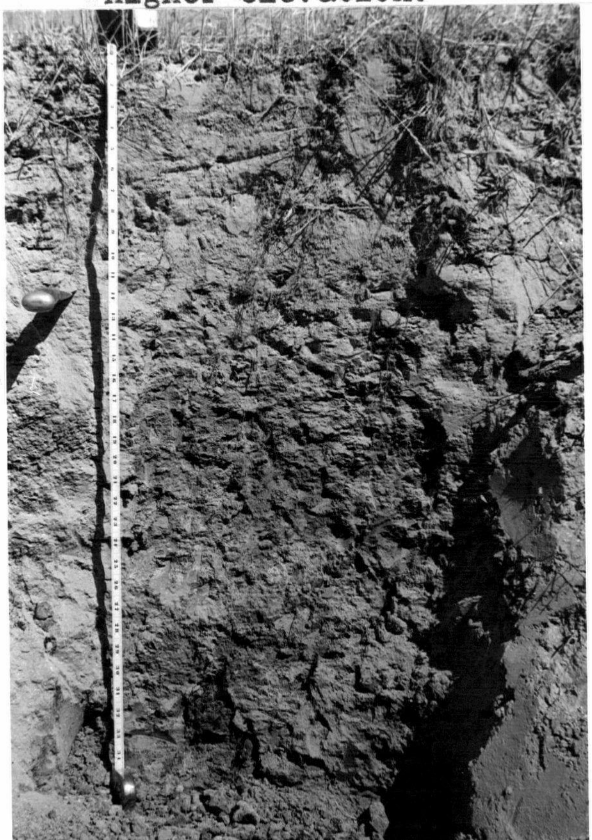
No stones were found in the profiles of Shoreacres silt loam.

Surface runoff is low and internal drainage is slow. Very little surface erosion is evident on this type. At the terrace edges however some gulleys

PLATE X



A. Shoreacres silt loam on level topography at right. Krestova loamy sand occurs on the higher elevation.



B. Shoreacres silt loam profile showing very little profile development below 18 inches.

are being cut. The silt loam type is particularly susceptible to gulleying because of its very low infiltration capacity.

At present most areas of this type have been abandoned and derelict orchards still remain on some small plots. Usually there is a very good stand of mixed grasses that are utilized very extensively for pasturing dairy cows and some areas are fenced off for hay production.

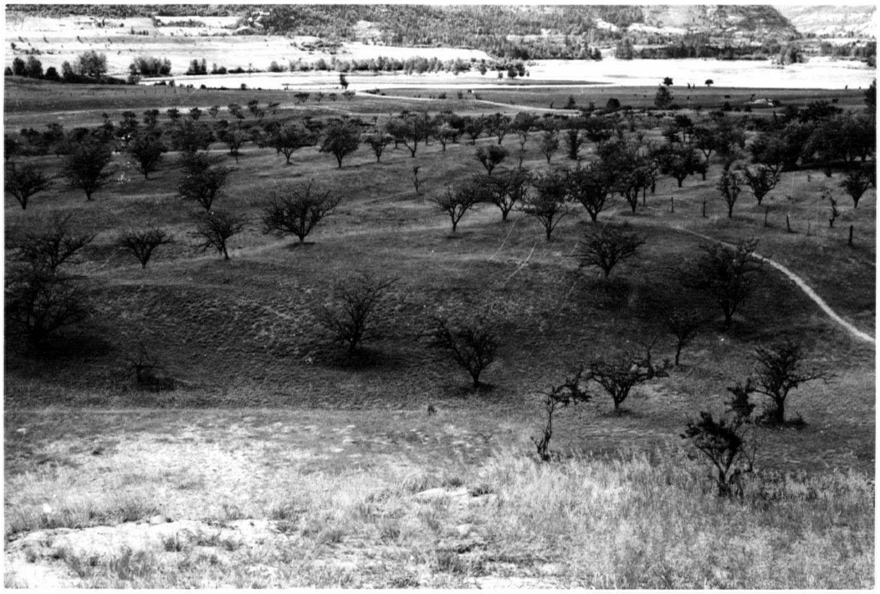
Shoreacres silt loam is quite productive and is desirable for farming. It was probably among the first soils to be cleared for cultivation. Since clearing, an A_1 horizon has developed in most places and this now obscures the surface characteristics of the original forest soil.

Shoreacres fine sandy loam

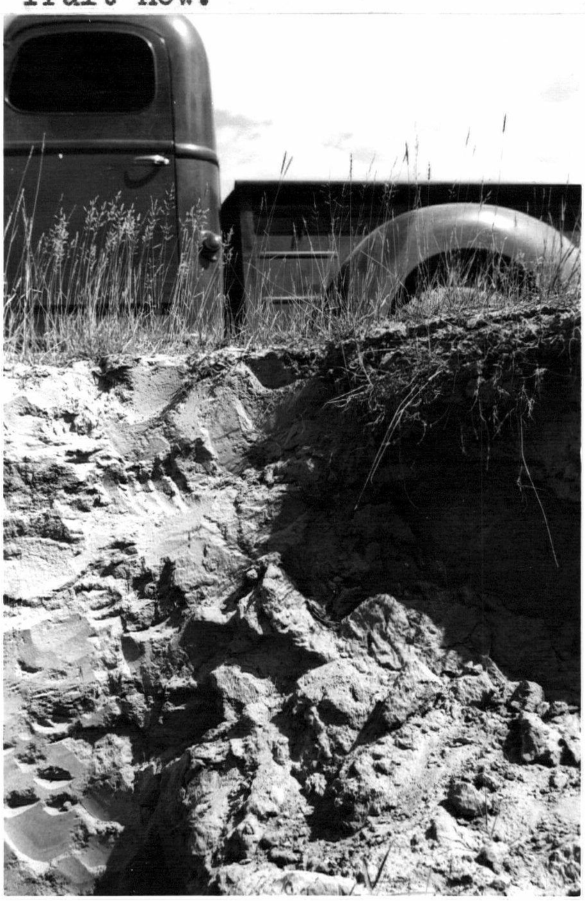
Two phases of this type were mapped, the level phase 453 acres and the sloping phase, 72 acres. The topography of the sloping phase is rather irregular due to the abandonment of old river channels as illustrated in Plate XI.

This soil is developed on alluvium consisting of strata of material ranging in texture from loamy fine sand to loam and within the soil profile a number of thin sand lens may occur. The surface texture of the level to gently sloping phase is quite uniform fine

PLATE XI



A. Sloping phase of Shoreacres fine sandy loam at Ooteshenie. Derelict orchard produces very little fruit now.



B. profile of Shoreacres fine sandy loam; an ideal soil for irrigation. The native vegetation of wheat grasses and bluegrasses can be seen.

sandy loam but the sloping phase exhibits a range of textures; loamy fine sand to loam depending on the influence of the old streams in their channels.

The profile description below was taken on an old orchard with a good stand of grass and legumes. The profile site is shown in Plate XII.

A_{1c}	0-6"	10YR 4/4 dark yellow brown (moist) 10YR 5/4 - 6/4 yellow brown (dry) fine sandy loam; moderate medium blocky, friable, very many roots. Top 2" is a mat of interwoven roots and soil is very friable. pH 5.5
A_{12}	6-9"	10YR 4/4 dark yellow brown (moist) 10YR 7/3 very pale brown (dry) fine sandy loam; moderate fine blocky, quite compact, many fine feeding roots. pH 5.5
B_1	9-15"	10YR 4/3 dark brown (moist), 10YR 7/4 - 6/4 very pale brown (dry) fine sandy loam; moderate fine blocky, quite compact, many fine roots. pH 5.5
Band	15-17"	10YR 5/3 brown (moist), 10YR 6/4 light yellow brown (dry) fine sandy loam; strong very coarse platy, very hard, few roots. discontinuous and occurring at different levels. pH 5.6
B_2	17-26"	10YR 6/3 pale brown (moist), 10YR 7/4 very pale brown (dry) sandy loam, massive, slightly compact. Very few roots. pH 5.8 Slight yellowish mottling.
C_1	26-35"	10YR 4/4 dark yellow brown (moist), 10YR 6/4 - 7/4 light yellow brown (dry) sandy loam; slight yellowish mottling, massive, quite compact, very few roots. pH 5.8
D	35" plus	10YR 4/4 dark yellow brown (moist), 10YR 6/4 - 6/6 light yellow brown (dry) loam; massive, very compact, no roots. pH 6.3

PLATE XII

Shoreacres fine sandy loam. The irregular dark brown bands in the subsoil are of common occurrence in this soil and are also frequently found in Krestova loamy sand. The steel cylinder at the top of the picture was used for infiltration and field capacity studies.

Soil bands or layers similar to the one described above from 15 to 17 inches are a regular feature of this type. Similar bands occur in some profiles of Krestova loamy sand.

Internal drainage of the fine sandy loam type is much more rapid than that of the silt loam and this feature makes it a more desirable soil under irrigation.

The fine sandy loam is probably less subject to sheet and gulley erosion than the silt loam because it has a higher infiltration rate being able to absorb a greater percentage of rainfall.

Much of this type is under similar cover to the silt loam type. Other areas are being used for gardens and are cultivated each year. This type is probably used in preference to the silt loam because of its easier workability.

Krestova Series (Brown Podzolic loamy sand and sand)

The series includes soils developed on coarse textured alluvium. It covers an area of 3,559 acres.

Three soil types were mapped in this series, loamy sand, sand and coarse sand. They occur on flat broad terraces up to 500 feet above river level.

Krestova loamy sand

The largest areas of this type are found in the communities of Ooteshenie, Krestova and Claybrick. In all, 1131 acres were mapped. The topography is level to gently sloping.

The following profile was described near the Crescent Valley bridge under a grass cover.

A_{1c} 0-6" 10YR 3/4 dark yellow brown (moist), 10YR 5/4 - 5/6 yellow brown (dry) loamy sand; weak fine granular, extremely friable, very many fine feeding roots. pH 6.1

B_1 6-10" 10YR 4/2 dark grey brown (moist), 10YR 7/2 - 6/3 light grey (dry) loamy sand; moderate medium blocky, many roots, extremely friable. pH 6.5

B_2 10-18" 2.5Y 5/4 light olive brown (moist), 10YR 7/2 light grey (dry) loamy sand; weak massive to single grained structure, extremely friable, many roots. pH 6.2

B_3 18-32" 10YR 5/2 - 5/3 grey brown (moist), 10YR 7/2 - 6/3 light grey (dry) sand, single grained, loose, roots. pH 6.2

Band 26-27" 10YR 4/3 dark brown (moist) 10YR 5/3 - 6/4 brown (dry) sandy loam; moderate very coarse platy, hard, few roots. pH 6.0 Discontinuous and occurring at varying levels usually below 13 inches.

C 32" plus 10YR 5/3 - 4/2 dark grey brown (moist) 10YR 6/3 pale brown (dry) sand; loose single grained. Very few roots pH 6.4

In some locations the C horizon is loamy sand texture and somewhat compact. This, however, does not impede internal drainage. The bands occurring in this profile are similar to those of the Shoreacres fine sandy loam but occur less frequently. Mechanical analysis shows them to contain 8-10 percent more clay and 5-6 percent more silt than the surrounding material.

If this soil were cultivated and left fallow considerable damage could result from wind action. Gulley erosion was noted only where a broken flume had released flooding waters or along the terrace edges where waters from heavy rains had accumulated.

A good deal of the drainage is through the porous sandy profile and is carried away by underlying gravels. Many small streams disappear on the terrace and presumably percolate to river level through gravel substrata as internal drainage is quite rapid.

Nearly all of the uncleared portions have had much of the valuable timber removed, so that the forest is now a second growth of pine, fir, birch, cottonwood and willow with a small amount of undergrowth such as hazelnut and rose. Most of the cleared areas have been left idle and are used for range only and many areas have a sparse grass cover. The loamy sand soils afford the best forage. Abandoned, derelict orchards are quite common. Forest regeneration is slow. After twenty years or more without cultivation significant regrowth occurs only along the forest edges.

Krestova sand

Large areas of this type, totalling 1,929 acres, occur at Ooteshenie, Glade, Pass Creek and Krestova communities.

For the most part, topography of Krestova sand is level to gently sloping and a typical example may be noted in Plate XIII. Two small areas of 0.6 acres each lie in kettle like depressions a few hundred yards west of the radio range station of the Dominion Department of Transport on the Krestova community. The steeper slopes of the kettles are mapped as eroded and non-arable. Some areas are slightly hummocky due to wind erosion.

No water accumulates in the kettles indicating the underlying strata are made up of porous sands and gravels that allow ground water to percolate away.

The profile description below was taken in Krestova community near the radio range station. The site was in a heavily logged forest with many young trees and regrowth. The profile represents the average zonal development of Brown Podsolic soils in the area.

A_0	2-0"	10YR 2/2 very dark brown (moist), 10YR 4/3 dark brown (dry) partially decomposed organic litter. Dead leaves twigs and some moss on surface. Some bits of charcoal, very many fine feeding roots. pH 5.4
A_1	0-¼"	10YR 2/1 black (moist), 10YR 3/2 very dark grey brown (dry) sand; weak medium blocky, very friable, many fine feeding

PLATE XIII

A. Krestova sand on level to gently sloping topography. Sparse grass cover with some bare spots showing up.

B. Forest regrowth on logged-over area of Krestova sand. Regeneration is slow.

roots, incipient. pH 5.4

A_2	$\frac{1}{4}$-$\frac{1}{2}$"	10YR 4/1 dark grey (moist) 10YR 4/2 light grey (dry) sand; single grained, very friable, many fine roots, incipient sometimes absent altogether, occurs at greatest depth under rotting logs. pH 4.8
B_1	$\frac{1}{2}$-4"	10YR 3/3 - 2/2 dark brown (moist), 10YR 4/4 5/4 dark yellow brown (dry) sand; weak fine blocky, very friable, numerous roots. pH 6.0
B_2	4-12"	10YR 4/3 - 3/3 dark brown (moist), 10YR 5/6 - 5/4 yellow brown (dry) sand; weak fine blocky, very friable, roots present. pH 6.0
C	12" plus	10YR 4/2 - 5/2 dark grey brown (moist) 10YR 6/3 pale brown (dry) sand; single grained, loose, very few roots. pH 6.0

Krestova sand is stone free. Internal drainage is rapid to excessive. The erosion hazards are similar to those of the loamy sand type.

No appreciable difference was noted in the vegetation cover between the sand type and the loamy sand type. However, forest regrowth, as seen in Plate XIII, is thought to be slower on the former due to greater general droughtiness.

Krestova coarse sand

Krestova coarse sand was mapped only on the communities of Ooteshenie and Glade and totalled 499 acres.

The macro-topography of Krestova coarse sand is level to gently sloping; but the micro-topography is made up of a pattern of very low (5 to 10 feet) crescentic shaped ridges which are the remnants of old barchan type wind dunes. These have now become stabilized by vegetation as shown on Plate XIV.

The profile described below was situated at the south end of Castlegar airport on Ooteshenie community. The site was in an abandoned orchard with sparse grass cover. The profile is similar to that shown in Plate XV.

A_1	0-6"	10YR 3/2 very dark grey brown (moist) 10YR 4/3 - 4/2 brown (dry) coarse sand; weak medium blocky, extremely friable, many fine grass roots pH. 5.5
B_1	6-14"	5YR 3/4 dark red brown (moist), 7.5YR 5/6 strong brown (dry) coarse sand; weak medium blocky, extrmmely friable, few roots. pH 6.0
B_2	14-26"	10YR 5/3-6/3 brown (moist), 10YR 6/3 pale brown (dry) coarse sand; single grained, loose, very few roots. pH 6.2
C	26" plus	10YR 6/2 light brown grey (moist) 10YR 7/2 light grey (dry) coarse sand; single grained, loose, no roots. pH 6.2

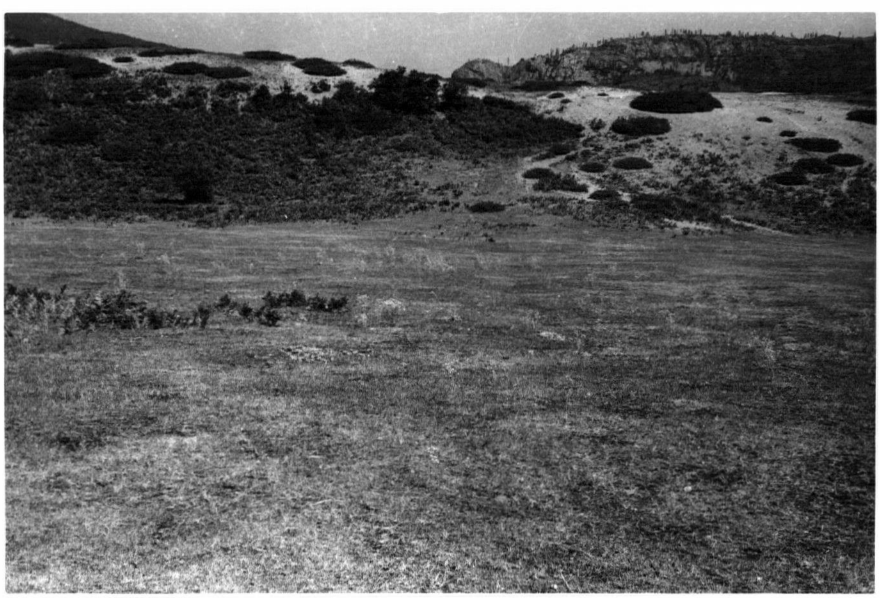
The profile is stone free though a few places are underlain at five feet or more by gravelly loamy sand strata containing cobbles.

Drainage on the coarse sand type is very excessive. Practically all of the drainage is through the extremely porous profile with little or no surface runoff except during very heavy rains.

Wind erosion is a great hazard, as evidenced

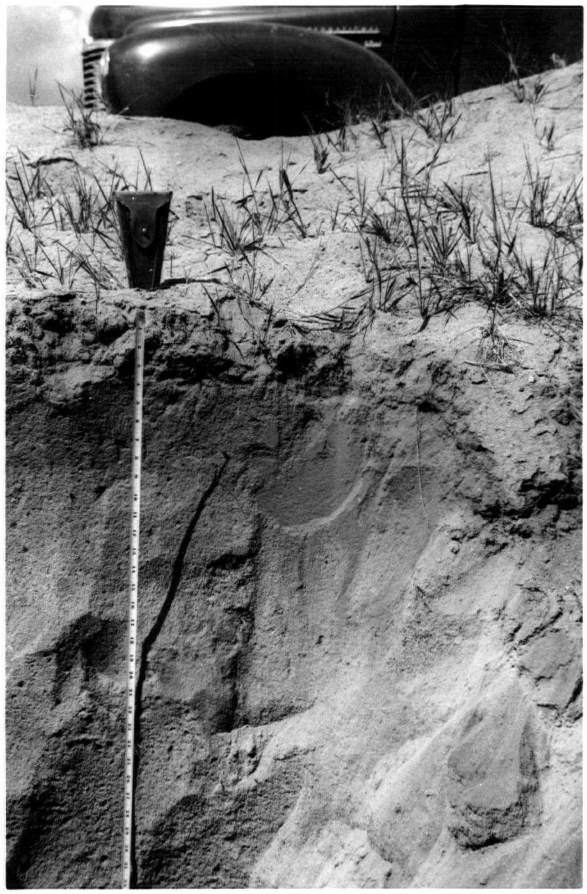
PLATE XIV

A. Krestova coarse sand on a broad flat terrace at Ooteshenie. White patches are old sand dunes that have been nearly stabilized by vegetation.



B. Sand dune at edge of a cliff in the process of being stabilized by vegetation. These dunes are found in association with Krestova coarse sand.

PLATE XV



Krestova coarse sand with shallow
development; a very droughty soil.

by the old dune ridges mentioned above. The top soil on these ridges is shallower than on the lower areas. Dry land cultivation would not be suitable because removal of stabilizing vegetation would subject this soil to renewed wind erosion. Some areas within this type are still being actively eroded. These areas are classed as dunes.

Gulley erosion is noted only where an irrigation flume has broken or where excess rain water has run off along the terrace edge.

Originally this soil was covered by forest vegetation similar to that of the loamy sand type. Much of it was cleared in the early nineteen hundreds. One large area at Ooteshenie was used for cereal crop production and this practice is believed responsible for the development of the dune topography. Forest regrowth on the coarse sand is extremely slow. Some areas mapped had a sparse cover of low shrubs but for the most part sparse grass cover was the only vegetation found.

Champion Series (Brown Podzolic gravelly sandy loam)

This series consists of soils developed on gravelly coarse textured alluvium containing some cobbles. It covers 1,073 acres on gravelly terraces. The Champion series occupies a similar position and has similar relief to the Krestova series. The main areas are at Champion Creek, Ooteshenie and Krestova.

Champion gravelly sandy loam

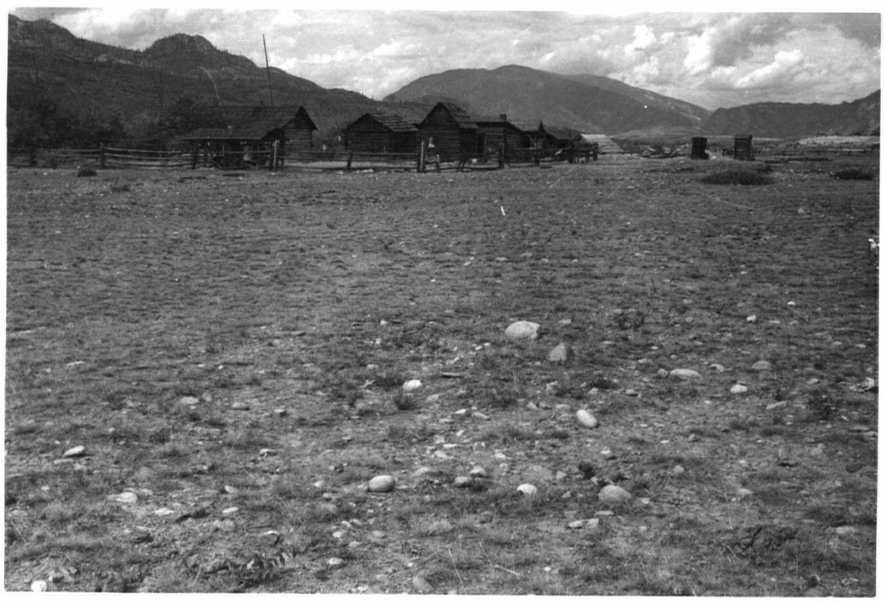
Two phases of this soil type were described, a non-stony phase amounting to 894 acres and a stony phase amounting to 179 acres. Topography of the Champion soils is level to very gently sloping.

Deep river laid gravels form the parent material of this soil. These gravels often underly the sandy Krestova parent material. In some places the Krestova sands may have been eroded leaving the gravelly surface exposed again. Gravel content made up mainly of rounded granitic pebbles ranges from 30 - 60 percent of total material and texture of the finer fraction ranges from sandy loam to loamy sand. Much of the material in the C horizon is a sand texture.

The following profile was examined in a recent excavation in a formerly cultivated field.

A_{1c}	0-6"	10YR 2/2 very dark brown (moist) 10YR 4/3 - 3/3 dark brown (dry) gravelly loamy sand; weak medium blocky, extremely friable, numerous grass roots, few small rounded cobbles pH 5.6
B_1	6-12"	10YR 3/4 - 4/4 dark yellow brown (moist) 10YR 5/6 - 4/4 yellow brown (dry) gravelly sand; weak medium blocky, extremely friable, few roots, few small round cobbles. pH 6.3
B_2	12-36"	10YR 5/2 grey brown (moist) 10YR 6/3 pale brown (dry) gravelly sand; single grained, loose. Some round cobbles and stones, no roots. pH 6.5

PLATE XVI



Champion gravelly sandy loam. A very poor soil without irrigation. Topography is level to gently sloping and amount of stones on the surface would hinder cultivation only slightly.

C 36" plus 10YR 4/2 - 5/2 dark grey brown (moist), 10YR 6/2 light brown grey (dry) gravelly sand; single grained, loose some round cobbles and stones, no roots, pH 6.5

Wind and water erosion has removed up to 50 percent of the topsoil on some of the low knolls. Infiltration rate is not as high on these soils as on the Krestova soils so that more water is obliged to run off. Gulley erosion occurs at the terrace edges where water may be concentrated down shallow gulleys.

There are large tracts of formerly cleared and cultivated land now with sparse grass cover or abandoned orchards and other areas of logged forest. Many of the very stony areas have not been cleared. A few small areas are under cultivation with irrigation for hay production and garden use. Much of this type is used for seasonal grazing.

Claybrick Series (Low humic glei on alluvium)

These soils which amount to 464 acres are situated along rivers or major streams ten to twenty feet above low water. They are imperfectly drained.

Claybrick loam

A total of 99 acres of this type occurs on the communities of Shoreacres, Krestova, Lebahdo and Claybrick. Because drainage is the dominant factor in these soils all the texture types have been placed in one series.

Topography is level to gently sloping with old abandoned channels crossing some areas in the form of long but rather shallow channels.

No material is now being deposited on this soil type as it is not normally subject to flooding. The surface is composed of a foot or two of alluvium generally finer in texture than the underlying material which is a loamy sand.

The following profile description was taken in a cultivated field.

A_{1c}	0-12"	10YR 3/4 dark yellow brown (moist), 10YR 6/3 - 5/3 pale brown (dry) sandy loam; moderate coarse blocky, quite firm, roots. pH 6.1
B_1	12-28"	10YR 3/3 - 4/3 dark brown (moist) 10YR 7/3 very pale brown (dry) sandy loam; some yellowish brown mottling, moderate medium blocky, firm, few roots. pH 6.6
B_{2g}	28-38"	10YR 4/4 - 5/4 dark yellow brown (moist), 10YR 7/3 - 7/2 very pale brown (dry) loam, moderate medium blocky, quite hard, brownish mottling. pH 6.8
D	38" plus	10YR 3/3 - 4/2 dark brown (moist) 10YR 6/2 light brown grey (dry) loamy sand, some brownish mottling, very weak, fine blocky, extremely friable, mica flakes. no roots. pH 6.6

The texture here is a heavy sandy loam but may vary to a loam. The profile is stone free. Some of the old channels and hollows may flood during high water in the spring. Internal drainage is somewhat impaired.

due to a high early season water table. The presence of a high water table is often beneficial in supplying moisture by sub-irrigation. Deep rooted crops such as alfalfa though do not do well because their root system is inhibited by high water.

Native cover consists of low shrubs, cottonwood and willow. Most of the loam type is cleared, producing hay, pasture crops and some garden crops. Gardens are nearly all irrigated by sprinkler from nearby streams.

Claybrick clay loam

This soil type was found only on Claybrick community where 36 acres were mapped lying a few feet lower than Claybrick loam and having a level topography.

The clay loam type has a slower internal drainage and is a "late" soil compared to others in the area. Its higher water holding capacity makes it quite drought resistant and would require less irrigation than would the lighter textured soils of the area.

Claybrick loamy sand

One hundred and eighty one acres of this soil type were found distributed throughout most of the communities. The topography is similar to Claybrick loam.

Claybrick loamy sand is quite subject to drought in mid-season but rather good yields of early crops are obtained without irrigation.

Claybrick gravelly sandy loam

Two phases of this type were mapped, the non-stony phase amounting to 111 acres and the stony phase amounting to 37 acres. The major part of this type occurs at Winlaw and Lebahdo communities.

The topography of the gravelly sandy loam type is similar to that of the loam type.

The non-stony phase is used for hay and pasture purposes up to mid season at which time drought is excessive. The stony phase is not used for hay but only for limited grazing. The native vegetation of this type is similar to that of the Claybrick loam.

Pass Creek Series (Humic glei on alluvium)

Three hundred and sixteen acres of this series were mapped as a loam and a sandy loam type and they occur at Pass Creek, Krestova, Lehabdo, Winlaw and Claybrick.

Soils of the Pass Creek series are imperfectly to poorly drained and show a greater glei horizon development than do the Claybrick series.

Pass Creek loam

A total of 222 acres of Pass Creek loam was found mainly on the communities of Pass Creek, Lebahdo and Winlaw.

The topography is level or very gently sloping with a basin relief. The type occurs at various elevations between river and the highest terrace levels. The large area at Pass Creek lies in a high basin between Pass creek and Goose creek and supplies drainage waters to both creeks. The Winlaw and Lebahdo areas are situated 10 to 20 feet above the Slocan river and their water table is kept high by seepage waters from peat bogs behind them. A small area at Claybrick is situated on a high terrace and surrounds a small pond.

The parent material is of varied origin, but since a very low slope is necessary for a high water table to develop these soils usually occur on alluvium. This alluvium is underlain at varying depth by gravelly stony river deposits indicating that the grade of the old river which once deposited gravels gradually lessened so that the river deposited finer material. Finally the area became almost flat resulting in the present condition which may be observed in Plates XVII and XVIII.

The following profile description was taken at Winlaw community in a cultivated area that had been drained by surface ditches.

A	0-12	10YR 2/1 black (wet), 10YR 4/1 dark grey (dry) loam, compact but friable, medium blocky structure, peds become very hard on drying, high organic

PLATE XVII

A. Pass Creek series at Winlaw. Dark loam high in organic matter underlain by a gravelly, bouldery deposit.

B. Flat topography of Pass Creek series in a wet situation with high water table a large part of the season.

content, low volume weight, grass sod with many roots. pH 6.4

G 12-30 10YR 4/2 dark grey (wet), 10YR 6/2 light brownish grey (dry) very fine sandy loam, some strong brown mottling, compact and very hard when dry, plastic when wet, few roots. pH 6.4

D 30 plus Brownish grey gravel and sand with many rounded cobbles up to ten inches in diameter.

Where these soils are better drained a reddish brown horizon occurs under the A horizon.

Very few stones occur in the surface horizons of Pass Creek loam but at many locations stones are found in the lower horizons and in some profiles they may be found at four feet.

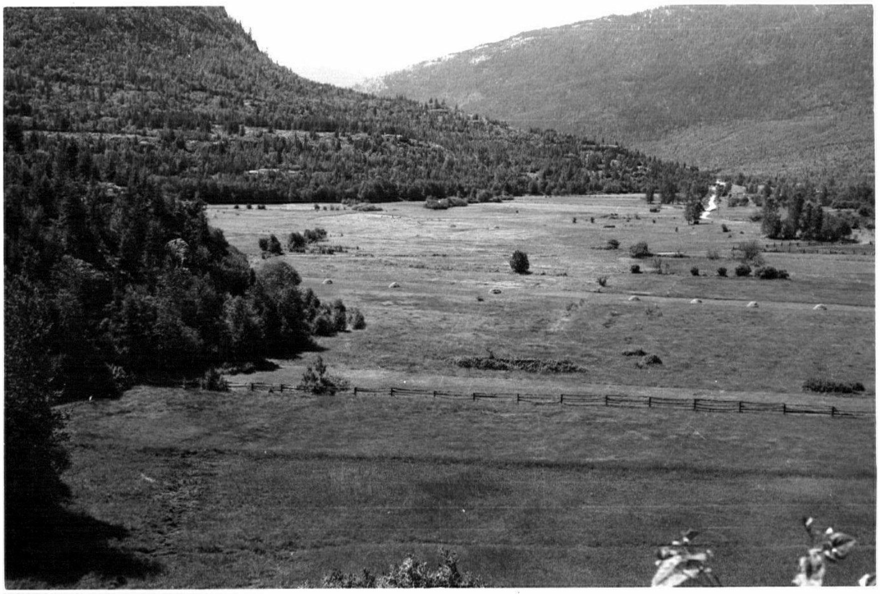
Natural drainage is always poor. Many of the cultivated areas have been drained by ditches which lower the water table a few feet. This artificial drainage allows the land to be used earlier in the spring and effectively lengthens the growing season.

Native cover consists of spruce, willow, cottonwood, sedge grasses and some underbrush. Much of this type has been cleared and is effectively used for permanent hay crops.

Pass Creek loamy sand

The loamy sand soil type occurs mainly in the Pass Creek and Krestova communities and a

PLATE XVIII



A. Pass Creek series on meadow lands in upper Pass Creek area. Drainage ditches take off excess water so that hay and garden crops can be grown.

B. Terraced gardens also on Pass Creek soil. They are irrigated by diverting creek water onto the terraces.

total of 94 acres was mapped.

Topography is similar to the loam type.

Stones are rarely found in the surface horizons, but some cobbles and boulders frequently occur in lower horizons.

There is very little difference between the natural vegetation found on the loamy sand and loam types. The loamy sand type produces moderately good yields of forage and garden crops.

Soils Derived from Alluvial Fans

Alluvial fan deposits of the West Kootenay area are similar to those described for the Grand Forks area but they cover a more extensive area and have therefore been mapped into soil types and phases.

Glade Series (Brown Podzolic alluvial fans)

A number of different soil types of the Glade Series are found on all communities and together they total 717 acres.

Glade gravelly loam

This type covers 110 acres, the major part of which is located at Glade community. The two phases, sloping and level to gently sloping, occupy 72 and 38 acres respectively.

Where cleared the main use is for pasture and hay. If water for irrigation is available from a permanent stream very good gardens, cereals or forage crops are obtained. However, most of these areas lie at or above the level of the highest terraces making it uneconomical to pump water from the river level.

Glade gravelly sandy loam compares very well with Shoreacres fine sandy loam in regard to productivity. The steeper and more irregular slopes make furrow irrigation difficult. There is more stones and gravel on the steeper slopes which also hinder furrow irrigation.

Glade loam

There is a total of only 9 acres of this type and these are located at Glade and Krestova. The Glade loam occurs at the lower end of fans where there is practically no gravel or stones. On the average the texture is somewhat heavier than the gravelly loam type making it a more desirable agricultural soil. Profile development is similar to that of Glade gravelly loam.

The topography is quite uniformly sloping to gently sloping. On the gentler topography less erosion and deposition occur. Surface and internal drainage are adequate.

At present the mapped areas of this type are used for pasture and garden purposes. They are quite productive without irrigation and with irrigation produce an excellent crop. Their original cover was probably similar to that of Glade gravelly loam.

There is a wide variation in gravel content. The upper parts of a fan deposit usually contain more gravel and also some stones and cobbles. As the slope decreases towards the bottom of the fan so does the gravel and stone content until it merges with the loam type.

The following profile description was taken on a slope of ten percent under a pasture cover.

A_1	0-1"	10YR 3/2 very dark grey brown (moist) 10YR 4/2 dark grey brown (dry) gravelly loam; granular, very friable, many roots. pH 6.0
B_1	1-8"	10YR 3/3 - 4/3 dark brown (moist), 10YR 5/4 yellow brown (dry) gravelly loam; fine platy, firm, numerous roots. pH 6.4
B_2	8-14"	10YR 4/2 dark grey brown (moist) 10YR 6/2 light brown grey (dry) gravelly loam; moderate fine blocky, quite compact, numerous roots. pH 6.5
C	14" plus	2.5Y 4/2 dark grey brown (moist) 10YR 7/2 light grey (dry) gravelly sandy loam; some yellowish mottling, massive, quite compact, roots. pH 6.6

At this particular location the A_1 horizon was very shallow probably due to sheet erosion. In other places on lower slopes this horizon may be up to 8 inches deep. The texture of this type varies from loam to sandy loam depending on conditions of stream depositions.

The gravel and coarse skeleton is composed of angular to subangular granitic fragments indicating they have not been transported far. Most of the cleared areas that were once cultivated have had the surface stones removed. The upper parts of the alluvial fans are very stony. Here the texture is usually coarser and the soil has been placed in the gravelly sandy loam type, stony phase.

Surface drainage is generally quite rapid. Internal drainage is generally good depending on the subsoil.

Originally this soil type supported similar vegetation to that which was supported by the Champion and Krestova soils, that is pine, fir, birch, aspen and willow, but it has now been quite heavily cut for lumber, poles, fenceposts and firewood so that only an immature forest is left with seedlings and scrub undergrowth.

Glade gravelly sandy loam

There are 129 acres of the non-stony phase and 469 of the stony phase distributed over the communities.

Topography on this type is quite irregular

PLATE XIX

A. Glade gravelly sandy loam profile on stream fan material. Rough stratification can be seen. A few inches of dark A_1 horizon has developed since clearing.

B. Extremely stony phase of Glade gravelly sandy loam, a non-arable soil.

due to numerous old stream channels.

In many respects Glade gravelly sandy loam is similar to the gravelly loam but the parent materials were laid down in swifter waters and the texture varies from sandy loam to loamy sand. The gravel and stone content is quite variable being more concentrated along old water coarses. The stony phase in general is not worth clearing for cultivation. Many areas have numerous large boulders. One area in particular lying on the main terrace at Glade is almost completely paved with boulders. This area cannot be recognized as a recent fan but seems to be the result of extreme erosion on an earlier glacial deposit of bouldery material. Similar profile development is obtained on this type as on Glade gravelly loam.

Drainage, both surface and internal, is variable depending on topography and underlying strata. No areas were found to be poorly or imperfectly drained and more commonly drainage was excessive or adequate.

A good deal of sheet and gulley erosion has occurred on the gravelly sandy loam. It is influenced mainly by topography. Deposition occurs in the lower areas. A few pockets of good soil occur within this soil type and some of them are cleared and used for hay or gardens. Original cover was probably similar to other forested locations in the general area.

Miscellaneous Soils

Peat

At Lebahdo 39 acres of peat lie behind the railway and road grade and at Winlaw 25 acres are situated in a depression at the base of a mountain from which seepage water drains. In both cases the water table is close to the surface at all times of the year and the peat deposits have built up.

The surface layers become aerated periodically and thus have undergone some decomposition but the lower layers remain as the raw undecomposed peat.

The topography is always flat or slightly convex. Sedge grasses and a few shrubs cover these areas. The drier spots are cut for hay but much of the area remains soft and spongy all season with water a few inches from the surface. If the very wet areas were adequately drained they too could be harvested regularly.

Dunes

Dunes are actively being formed by wind action at Champion Creek, Ooteshenie and Brilliant communities and at present they occupy 37 acres.

The dunes may be 10 to 30 feet high and a typical example of them may be seen in Plate XX.

The dunes are continually shifting causing

PLATE XX

A barchan type of dune found in an area of Krestova coarse sand. Note the crescentic shape. Vegetation growing between the "horns" of the crescent is beginning to stabilize this dune. Scanty grass cover may be seen attempting to establish itself on the dune.

some threat to adjacent productive soils. However, at the present time they do not appear to be advancing rapidly and vegetation may eventually stabilize them.

Eroded and Dissected Land

In the West Kootenay area 2122 acres of land was classed as eroded and dissected. It consists of steep terrace faces and deep eroded gulleys.

These soils which are distributed throughout the communities are actively eroding only in a few places as vegetation on the steep slopes has halted soil creep and down slope movements.

These areas are considered wild land with no important value for agriculture.

Rough Mountainous Land

Land classed as rough mountainous consists of steep, rocky or mountainous slopes and on the Doukhobor communities of the West Kootenay it comprises 4254 acres.

Most of these lands are forested and some have been logged. At present they supply the communities with fuel, posts and poles. Some of these areas have been severely overcut and show evidence of soil erosion.

SOIL TESTS CONDUCTED IN THE FIELD AND LABORATORY

To further characterize the more important soil series described during the soil survey operations, a number of tests were made in the field and laboratory. The tests made and the procedures followed are summarized below.

Bulk samples were collected from each horizon of the more important soil profiles and these were used for the determination of total carbon by the dry combustion method and the total nitrogen by the Kjeldehl method as prescribed by the Association of Official Agricultural Chemists methods of analysis (2). From the results of the carbon and nitrogen determinations the carbon nitrogen ratio was calculated and the total organic matter content was calculated by multiplying the percentage carbon by the factor 1.724 (2).

The reaction of each sample was determined using a Beckman Model "N" PH meter according to the soil paste method of Doughty (20). The results of these tests were included with the soil profile descriptions given previously.

Mechanical analyses were made on a number of the bulk samples using the Bouyoucos hydrometer method (5) as modified by Toogood and Peters to allow for organic matter removal (48). In the case of the coarser textured samples, a further examination of the sand fraction was made by passing the sample over a 100 mesh seive with openings of 0.149 millimeters.

Soil from a number of the bulk samples was used for the determination of the permanent wilting percentage by direct estimation with sunflower plants as described by Work and Lewis (58). Indirect estimate of the wilting percentage or the fifteen atmosphere percentage was made on other samples using the pressure membrane apparatus as described by Richards (38) (39). When using the pressure membrane method, samples of soil for which the permanent wilting percentage had been found with sunflowers were included as a control.

Moisture equivalent determinations as described by Briggs and McLean (7) were also made using soil from the bulk samples.

At the time the bulk samples were collected in the field, a number of other observations were made and samples collected in brass cylinders. The procedure followed included using two stainless

PLATE XXI

Pressure membrane apparatus with mercury differential regulator and high pressure nitrogen gas cylinder used for laboratory determinations of permanent wilting point.

steel cylinders, 16" in diameter and 12" high and open at both ends, which were forced into the soil to a depth of 6". Water was then allowed to run inside the cylinders at a controlled rate so that a head of 1" of water was maintained on the soil surface. The rate at which the water was added was recorded by following the level of water in a site gauge fastened to the water reservoirs. Readings were taken at 15 minute intervals then at 30 minute intervals and finally at hourly intervals until the rate of water entry into the soil became constant. When sufficient water had been added to moisten the soil to the depth of at least three feet the cylinders were removed and the soil covered to prevent evaporation. This method of adding water to the soil has been used as an indication of the infiltration of the soil (26).

The sites were left covered for one to three days depending upon the texture of the soil after which profile pits were then dug through each site and soil cores taken from each horizon using a sampling tool (3) equipped with 3" brass liners. Four separate cores were taken from each horizon and these were carefully trimmed and weighed immediately, in the field so that the moisture content of these field soils could be later calculated. The moisture retained under such circumstances has been used as an estimation of field moisture storage capacity (10). The trimmed cores were then carefully packed and shipped to the soil laboratory at the University of British Columbia for further study.

In the laboratory the cores were used for the estimation of pore size distribution, permeability and apparent specific gravity. A filter paper and a piece of muslin was first placed over the bottom of each core and held in place with an elastic band. The cores were then placed in a suitable container and the level of water in the container gradually raised over a period of 12 hours until the soil was completely saturated. Flooding of the cores was avoided. After the cores had been allowed to remain saturated for 24 hours they were removed and immediately weighed on a watch glass to give the saturated weight. The cores were then placed on a tension table of the type described by Leamer and Shaw (28), and allowed to come to equilibrium at tensions of 10, 20, 40, 60, and 80 centimeters of water.

Following the final weighing at 80 cm. tension the cores were again saturated and a 1" brass cylinder taped in place on top of each. After supporting the saturated cores above the beakers, a constant head of water equivalant to ½" was kept on the soil in each core and the rate at which water passed through it was determined by measuring, at specified intervals, the water which collected in the beakers (4) (42). From these values the hydraulic or water conductivity of the soil in the cores was calculated (44).

When the rate of water flow through the cores reached a constant value the cylinders were removed and the soil allowed to dry to constant weight at 110° centigrade. From the weight of the oven dry soil the apparent specific gravity of the field soil was calculated.

RESULTS OF FIELD AND LABORATORY TESTS

Chemical Analysis

Horizon samples from five profiles representing important soil series were analysed for total carbon and nitrogen and the results together with reaction values are listed in Table 9. The horizons of Claypit silt loam below 20 inches were not included as they contain large amounts of inorganic carbon in the form of carbonates which would have interfered with the total carbon determination by the dry combustion method used.

From the reaction values included in Table 9, together with those given previously in the profile descriptions, it is evident that the Black soils of the Grand Forks area are neutral to slightly acid in the surface and mildly to moderately alkaline in the lower horizons. The Brown Podzolic soils of the West Kootenay area are somewhat more acid varying from about pH 5.0 to pH 6.0 or strongly acid to medium acid in the surface to medium and slightly acid in the deeper horizons.

The results of Table 9 also show that the Black soils of the Grand Forks area generally contain more organic carbon and nitrogen to a greater depth than do the Brown Podzolic soils of the West Kootenay area. In the Brown Podzolic soils the carbon and nitrogen is concentrated close to the surface. These differences are what may normally be expected for these two soil groups.

For a Black soil, the carbon content of Carson loamy sand is rather low, 0.5 percent. This soil has a high percentage of macropores which allows a great deal of aeration and a high rate of oxidation of organic matter. At various times this soil has been affected by wind erosion and this would also lead to a lower carbon and nitrogen content.

The cultivated surface horizon of Shoreacres fine sandy loam has a rather high carbon and nitrogen content due to a sod cover, but below this horizon both carbon and nitrogen are very low.

The high amount of carbon in the upper 4 inches of Krestova sand can be accounted for by the presence of charcoal residues from past forest fires.

It is also of interest to note that the carbon to nitrogen ratios of the Black soils of the

TABLE 9

CARBON, NITROGEN AND ORGANIC MATTER CONTENT

OF SOME GRAND FORKS AND WEST KOOTENAY SOILS

(Percent by weight of oven dry soil)

Soil Type and Horizons		Depth (Inches)	Soil Reaction (pH)	Carbon	Nitrogen	C:N Ration	Organic Matter (Cx1.724)
Grand Forks Area							
Claypit silt loam	A_{1c}	0-6	5.8	2.735	0.242	11.28	4.72
	A_{12}	6-12	6.0	1.271	0.135	9.42	2.20
	B	12-20	6.5	0.371	0.047	7.90	0.64
Carson loamy sand	A_1	0-14	6.0	0.571	0.056	10.20	0.99
	B_1	14-24	6.0	0.343	0.035	9.79	0.59
	B_2	24-40	6.5	0.170	0.014	12.14	0.29
Hardy gravelly loam	A_{1c}	0-8	7.0	4.167	0.343	11.15	7.20
	A_{12}	8-26	6.8	2.650	0.193	13.73	4.57
	A_3	26-34	6.9	1.846	0.155	11.90	3.19
	B_1	34-50	6.9	0.725	0.074	9.80	1.25
	B_2	50-64	7.0	0.345	0.031	11.12	0.60
West Kootenay Area							
Shoreacres fine sandy loam	A_{1c}	0-2	5.5	3.210	0.194	16.55	5.54
	A_{1c}	2-6	5.5	1.307	0.072	18.15	2.26
	B_1	6-12½	5.5	0.174	0.015	11.60	0.30
	Band	12½-14	5.6	0.176	0.018	9.78	0.30
	B_2	14-20	5.8	0.118	0.010	11.80	0.20
	Band	20-22	5.8	0.122	0.016	7.64	0.21
	C_1	22-36	5.8	0.159	0.019	8.38	0.27
Krestova sand	B_1	½-4	6.0	0.813	0.079	22.90	3.13
	B_2	4-12	6.0	0.620	0.045	13.79	1.07
	C	12-36	6.0	0.091	0.004	22.70	0.16

Grand Forks area are generally lower than those of the Brown Podzolic West Kootenay soils. This indicates a more advanced state of decomposition of the organic matter in the Black soils and again is in accord with what is usually expected for these two types of soil (40). It may be concluded from these results, that the Black soils are better supplied with total nitrogen and would release more available nitrogen for plant growth than the Brown Podzolic soils.

Mechanical Composition

The results of the mechanical composition analysis are summarized in Tables 10A and 10B and are expressed according to the International system of particle size separation (50). The textural classes included in the tables are based on the U.S.D.A. texture triangle (50).

It will be noted that a number of the soil samples were analysed both with and without peroxide treatment and that in all instances higher clay percentages were found with peroxide treatment. This emphasizes the importance of the peroxide treatment to destroy the cementing effect of organic matter and achieve complete dispersion, particularly in surface horizons (48). It is seen, however, that the increase in clay content by the use of peroxide treatment was sufficient to change the textural class of only two soil horizons; the B horizon of Claypit silt loam and the A_{1c} horizon of Shoreacres silt loam.

The analysis, both with and without peroxide treatment showed the surface horizons of Claypit silt loam to be clay loam, tending only slightly toward silt loam. The clay size fraction of this soil may not be of the platy montmorillonite type but rather a very finely ground glacial debris that would not exhibit the usual stickiness when textured by hand.

The clay content of Carson loamy sand is shown to be too low for the loamy sand class. However when treated with peroxide this soil nearly approaches a loamy sand.

With the exception of Shoreacres silt loam the West Kootenay soils are also generally low in clay content. These soils are developed on terraces laid down by glacial rivers which do not normally carry a large amount of clay size particles or clay minerals.

The dark brown hard band of Krestova loamy sand contained 8 percent more clay and 6 percent more silt than the material surrounding it. The origin of these soil bands or layers is uncertain but they are believed to arise during soil development.

TABLE 10A

MECHANICAL COMPOSITION AND TEXTURAL CLASSES[1] OF SOME GRAND FORKS SOILS

(PERCENT BY WEIGHT OF OVEN DRY SOIL, LESS THAN 2 M.M. FRACTION)

Soil Type and Horizons		Depth (inches)	Coarse[2] Skeleton	No Peroxide Treatment: Coarse[3] Sand	No Peroxide Treatment: Total Sand	No Peroxide Treatment: Silt	No Peroxide Treatment: Clay	No Peroxide Treatment: Textural Class	Peroxide Treatm.: Total Sand	Peroxide Treatm.: Silt	Peroxide Treatm.: Clay	Peroxide Treatm.: Textural Class
Claypit silt loam	A_{1c}	0-6	0		32	36	32	CL	28	32	40	CL
	A_{12}	6-12	0		28	38	34	CL	23	37	40	CL
	B	12-20	0		26	34	40	CL	25	33	42	C
	C_1	20-24	0		23	27	50	C				
	C	24-54	0		31	25	44	C				
Carson loamy sand	A_1	0-14	0	56	91	7	2	S	89	7	4	S
	B	24-34	0		94	6	0	S				
Carson sandy loam	A_{1c}	0-8	0	6	69	31	0	SL	60	26	14	SL
	B	21-44	0	5	67	31	2	SL				
Hardy gravelly loam	A_{1c}	0-8	33	26	71	24	5	SL	58	26	16	SL
	A_{12}	8-26	30						60	22	18	SL
	B_1	34-50	51	32	71	25	4	SL				
Hardy loam	A_{1c}	0-12	7						46	28	26	L

1 Based on International System of particle size separation and textural triangle in Soil Survey Manual (50).
2 Greater than 2 m.m. fraction.
3 By wet seivins

TABLE 10B

MECHANICAL COMPOSITION AND TEXTURAL CLASSES[1] OF SOME WEST KOOTENAY SOILS
(PERCENT BY WEIGHT OF OVEN DRY SOIL, LESS THAN 2 M.M. FRACTION)

Soil Type and Horizons		Depth (inches)	Coarse[2] Skeleton	No Peroxide Treatment: Coarse Sand[3]	No Peroxide Treatment: Total Sand	No Peroxide Treatment: Silt	No Peroxide Treatment: Clay	No Peroxide Treatment: Textural Class	Peroxide Treatment: Total Sand	Peroxide Treatment: Silt	Peroxide Treatment: Clay	Peroxide Treatment: Textural Class
Shoreacres fine sandy loam	A_{1c}	0-6	0	5	63	31	6	FSL	54	32	14	FSL
Shoreacres silt loam	A_{1c}	0-9	0	10	59	34	7	VFSL	52	34	14	L
	B_1	9-12	0	2	22	31	47	C				
	C	32 +	0		16	20	64	C				
Krestova loamy sand	A_{1c}	0-6	0	9	75	24	1	LS				
	B_2	10-18	0		79	21	0	LS				
	B_3	18-32	0		94	5	1	S				
	Band	26-27	0	26	80	11	9	SL				
	C	32-40	0	24	95	5	0	S				
Krestova sand	B_1	1-4	0	47	83	13	4	LS	6	14	80	LS
	B_2	4-12	0	50	87	11	2	S				
	C	12-30	0	72	93	1	1	CoS				
Krestova coarse sand	A_{1c}	0-6	2	79	93	5	2	CoS				
	C	14 +	0	88	98	2	0	CoS				
Champion gravelly sandy loam	A_{1c}	0-6	22	68	85	12	3	LS				
	B_1	6-12	28	61	89	9	2	S				
	B_2	12-36	66	87	98	2	0	S				
Claybrick loam	A_{1c}	0-12	0		59	32	9	SL	16	31	53	SL
	B_{2g}	28-38	0	1	32	49	19	L				
	D		0		84	11	5	LS				

1 Based on International System of particle size separation and textural triangle in Soil Survey Manual (50).
2 Greater than 2 m.m. fraction.
3 By wet seivins

The profile of Claybrick loam showed an increase in clay content in the B_{2g} horizon. This would indicate a movement of clay out of the surface horizon.

The two gravelly soils, Hardy gravelly loam and Champion gravelly sandy loam have percentages of coarse skeleton ranging from 22 to 66 based on the whole soil. Soils containing more than 15 - 20 percent coarse skeleton, or fragments between 2 m.m. and 10 inches in diameter, are named according to the type of fragment they contain (50). Thus these soils are described as being gravelly.

Apparent Specific Gravity, Total, Macro- and Micro-pore Space and Hydraulic Conductivity

The results of the apparent specific gravity, porosity and hydraulic conductivity tests are summarized in Table 11, and are shown graphically in Figure 3.

The values for apparent specific gravity are averages of four individual results. It will be noted from Table 11 that the apparent specific gravity values for the Grand Forks soils vary from 1.05 to 1.52 and that in several the values increase with depth. Also, the values are lower for the fine textured soils.

The apparent specific gravity values for the West Kootenay soils show a similar range to the Grand Forks soils, 1.05 to 1.56, however the increase with depth is not as consistent. The B_1 horizon of Shoreacres silt loam has a high apparent specific gravity of 1.56 that may be due to compaction of tillage implements in the manner that a plow sole developes.

The macropore space shown in Table 11 and Figure 3 corresponds to the percent of soil volume drained by a tension of 40 cm. water, or pF 1.6, and is the percent of soil pores with effective radius of 0.0333 m.m. or larger. Considering the Grand Forks soils first it will be noted from Table 11 that the macropores of these soils range from 3 to 10 percent and that in general the Claypit silt loam has the highest percentage and the Carson loamy sand the lowest. These results indicate that the Claypit silt loam has a good structure, that is, the individual particles, clay, silt and sand are well grouped into aggregates that provide pore space. The low macropore space in Carson sandy loam probably reflects a lack of structural aggregates. It will be noted from the mechanical data in Table 10A that this soil is very low in clay but high in silt and fine sand. It has often been observed that soils high in silt have little structure and a low macropore space and apparently in this case the condition is further aggravated by the high content of fine sand which has favored close packing. However, considering the texture of the material, the macro-pore space would not be considered low enough to be an important limitation

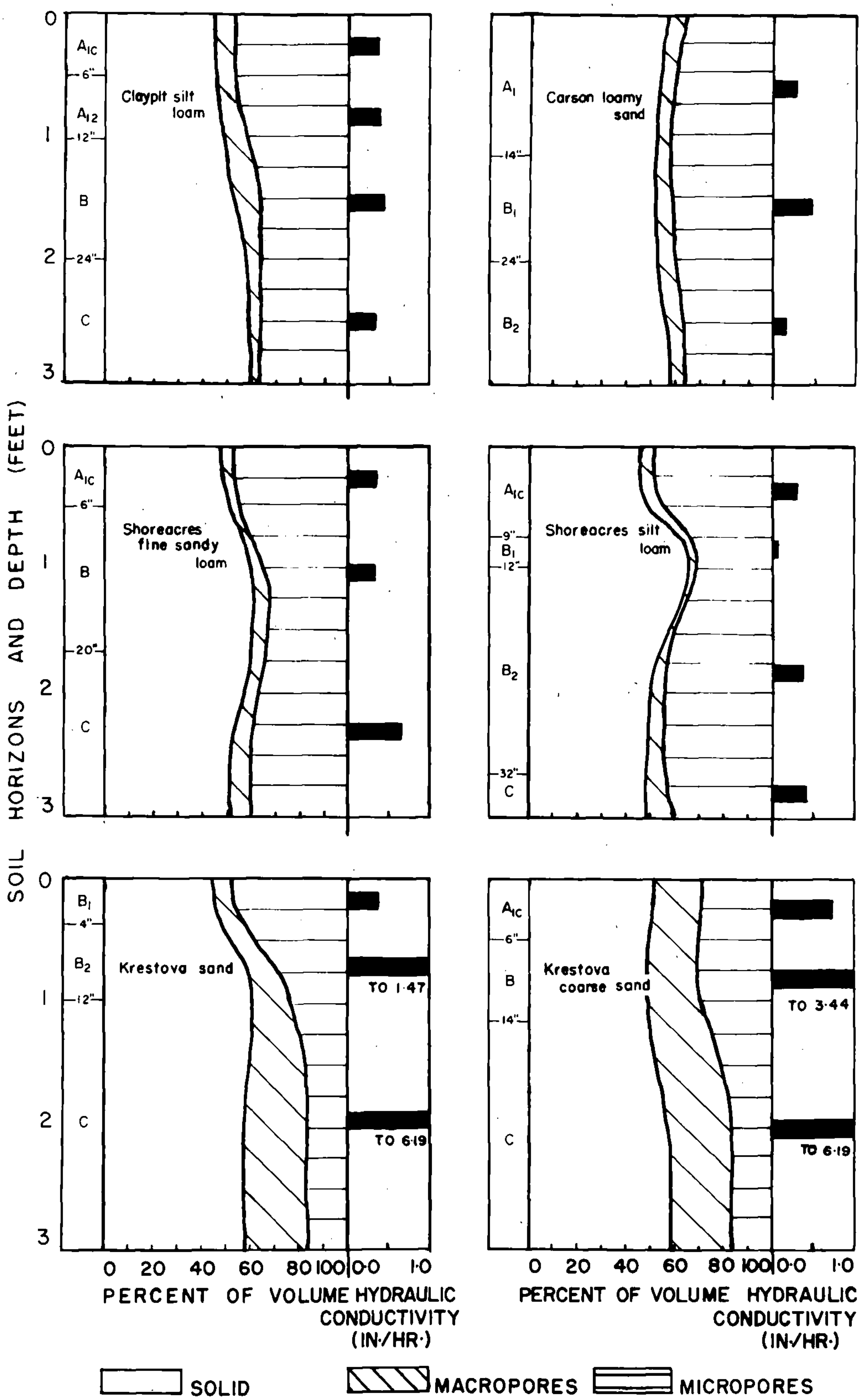
TABLE 11

APPARENT SPECIFIC GRAVITY, POROSITY AND HYDRAULIC CONDUCTIVITY OF SOME GRAND FORKS AND WEST KOOTENAY SOILS

Soil Type and Horizons		Sample Depth	Apparent Specific Gravity	Pore Space (% of Tot. Vol.)			Hydraulic conductivity (ins. per hour)	
				Macro-Pores[1]	Micro-Pores[2]	Total Pores[3]	Maximum.	End of 8 hrs.
Grand Forks Area								
Claypit silt loam	A_{1c}	1-4	1.05	8	48	56	0.41	0.37
	A_{12}	8-11	1.08	7	45	53	0.82	0.38
	B	15-18	1.39	10	37	46	0.70	0.43
	C_1	27-30	1.52	5	37	42	0.31	0.31
	C	54-57	1.46	6	37	43	0.27	0.16
Carson loamy sand	A_1	3-6	1.37	5	40	46	0.38	0.29
	B	24-27	1.41	7	41	48	0.52	0.47
	C	42-45	1.41	7	36	43	0.27	0.16
Carson sandy loam	A_{1c}	3-6	1.14	3	49	52	0.15	0.13
	B	12-15	1.11	3	56	59	0.81	0.69
	C	28-31	1.20	3	51	54	0.27	0.16
West Kootenay Area								
Shoreacres fine sandy loam	A_{1c}	0-3	1.10	7	49	57	0.51	0.51
	A_{1c}	2-5	1.22	4	48	52	0.35	0.35
	B	10-13	1.40	6	34	40	0.45	0.33
	C	28-31	1.33	6	40	46	1.59	0.67
Shoreacres silt loam	A_{1c}	1-4	1.05	2	51	53	0.31	0.31
	B_1	9-12	1.56	3	32	35	0.09	0.07
	B_2	20-23	1.42	5	43	48	0.64	0.39
	C	32-35	1.26	10	42	51	0.67	0.43
Krestova sand	B_1	1-4	1.27	8	48	55	0.40	0.38
	B_2	8-11	1.42	11	30	42	1.59	1.47
		20-23	1.45	25	17	42	7.40	6.19
Krestova coarse sand	A_{1c}	1-4	1.37	16	29	45	0.82	0.75
	B	10-13	1.28	21	31	51	4.15	3.44

1 Taken as percent of pores drained at 50 cm. tension
2 By difference
3 Calculated from saturated weight of core.

FIGURE 3



PORE SPACE AND HYDRAULIC CONDUCTIVITY

on plant growth.

It will be noted from Table 11 and Figure 3 that the total pore space of the soils examined ranged from a low of 35 percent in the B_1 horizon of Shoreacres silt loam to a high of 59 percent in the B horizon of Carson sandy loam. In general, the total pore space was inversely related to the apparent specific gravity and was higher in the surface horizons.

For most of the soils examined more than one-fifth of the total pore space was made up of fine or micropores. In Carson loamy sand the fine pores constituted nearly 95 percent of the total pore space. The lower horizons of Krestova sand and the profile of Krestova coarse sand are quite different in that the micropores make up less than three-quarters of the total pore space.

It will be noted in Table 11 that two figures are given for hydraulic conductivity, the first is the maximum value reached during the experiment and the second is the value obtained at the end of 8 hours at which time the conductivity rates appeared to be approaching a constant rate. This latter figure was used in preparing Figure 3.

The hydraulic conductivity values shown in Table 11 range from 0.07 inches per hour in the B_1 horizon of Shoreacres silt loam to 6.19 inches per hour in the C horizon of Krestova sand. In comparing hydraulic conductivity with macropore space there is a general relationship evident. The horizons with the lowest hydraulic conductivity have the lowest macropore space and horizons with the highest hydraulic conductivity have the highest macropore space. Also, although the hydraulic conductivity values differ considerably, as do the percents macro-pore space, they are all generally high and should not present a problem in the intake or drainage of water.

Field Infiltration Rates

Included in Table 12 are the rates of water infiltration observed using the small rings employed for wetting the soil prior to collecting the soil core samples. It should be emphasized that these rates may be used for purposes of comparison only, and would be higher than expected under field conditions. In this regard it should be noted that sinking the rings into the soil disturbs the soil to some extent and also, there is a great deal of opportunity for lateral movement of water below the rings.

A consideration of the infiltration rates in Table 12 show that with two exceptions the infiltration of water decreased from the first half hour period and the decrease was greatest in the soils containing the most silt and clay. The greatest reduction occurred in the Shoreacres silt loam which decreased from 5.6 to 0.6 inches per hour. In the case of the very coarse textured soils it will be noted that there was little or no reduction in the infiltration rate during the tests.

The effect of a sod cover is shown quite markedly in Shoreacres fine sandy loam where the infiltration rates under sod cover and under clean cultivation are 4.1 and 1.5 inches per hour respectively. This would indicate that some difficulty may be encountered due to erosion from runoff when this type of soil is irrigated with no cover. With the exception of Shoreacres silt loam and fine sandy loam and Claypit silt loam the infiltration rates of all the soils studied are generally high.

Field Moisture Capacity, Moisture Equivalent, Permanent Wilting Point and Available Moisture

The field capacity values reported in Tables 13 and 14 and shown in Figure 4 were found by applying water to a small area of soil and then allowing the soil to drain for one to three days after which time samples were taken for the determination of moisture. It will be noted that a wide range in results were obtained, from low of 2 percent in the B_2 horizon of Danville loamy coarse sand to a high of 35 percent in the A_{1c} horizon of Claypit silt loam.

TABLE 12

FIELD INFILTRATION RATES FOUND FOR SOME GRAND FORKS AND WEST KOOTENAY SOILS

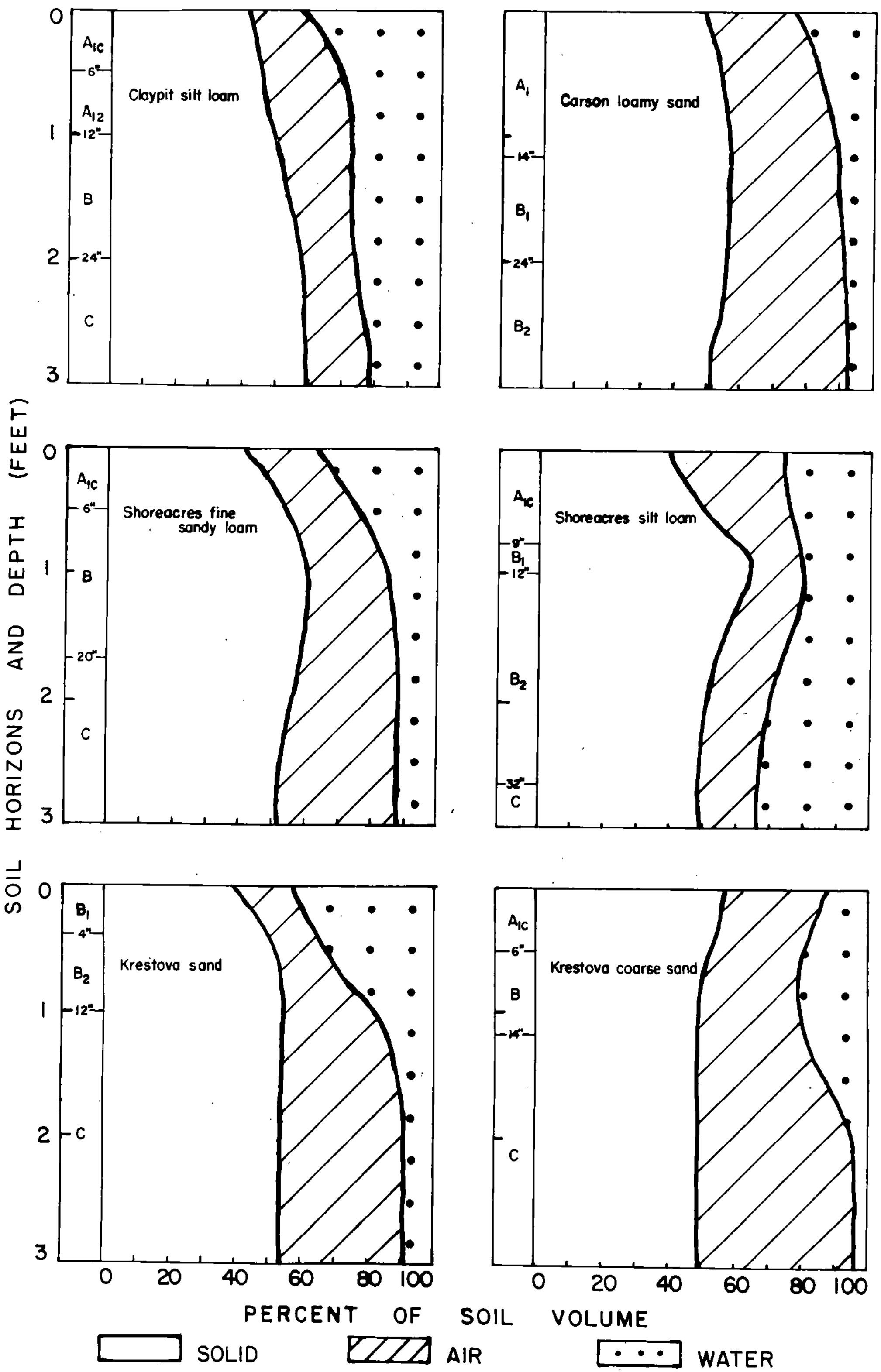
Soil Type	Rate of Infiltration Inches per hour	
	First ½ hour	After first ½ hour
Grand Forks Area		
Claypit silt loam	3.5	1.9
Carson loamy sand	5.7	4.4
Hardy gravelly loam	2.8	3.0
Danville loamy coarse sand	3.9	2.5
West Kootenay Area		
Shoreacres fine sandy loam		
- sod cover	7.0	4.1
- no cover (cultivated)	4.8	1.5
Shoreacres silt loam	5.6	0.6
Krestova sand	3.1	4.2
Krestova coarse sand	7.6	4.8
Champion gravelly sandy loam	6.6	4.0

When the field moisture capacity results are considered in relation to the mechanical analysis values it is apparent that the horizons with the highest proportion of fine materials are those with the highest field moisture capacity. Also, in the case of the surface horizons, it is evident that the organic material has also contributed to this property.

In Tables 13 and 14 the field moisture capacity values are given on a percent by weight basis. Using the apparent specific gravity values obtained for each horizon, these values may be expressed on a volume basis. Also, since the total porosity of the soil is known, the volume of the soil occupied by air at its field moisture capacity may be calculated. This was done for the soils under study, and the results for six of them are shown graphically in Figure 4.

It will be noted from Figure 4, that when at their field moisture capacity, the six soils had different proportions of solid liquid and air. In all cases, however, the volume of air was sufficient that the soils could be considered to be well aerated. Also, the very low volume occupied by water, even at field moisture capacity, is very noticeable in the cases of Carson loamy sand, Krestova sand and Krestova coarse sand.

FIGURE 4



PERCENT SOLID MATERIAL, AIR AND WATER AT FIELD CAPACITY

TABLE 13

FIELD MOISTURE CAPACITY, MOISTURE EQUIVALENT, PERMANENT WILTING POINT AND AVAILABLE MOISTURE OF SOME GRAND FORKS SOILS

(Percent by weight of oven dry soil)

Soil Type and Horizons		Depth (inches)	Field Capacity	Moisture Equivalent	Permanent Wilting Point	Inches Available Moisture to 3 ft. depth
Claypit silt loam	A_{1c}	0-6	35	30	15^{x}	1.2
	A_{12}	6-12	28	26	13	0.9
	B	12-24	22	22	14	1.3
	C	24-36	15	22	12	0.5
		0-36				3.9
Carson loamy sand	A_1	0-14	12	8	4^{x}	1.5
	B_1	14-24	7	7	3	0.6
	C	24-36	6	5	3	0.4
		0-36				2.5
Carson sandy loam	A_{1c}	0-8	22	20	7	1.4
	B	8-21	15	17	5	1.4
	C	21-36	15	17	6	1.7
		0-36				4.5
Danville loamy coarse sand	A_{11}	0-7	12	20	5^{x}	
	A_{12}	7-12	8	14	3	
	B_1	12-18	4	6	1	
	B_2	18-24	2	3	1	
Hardy gravelly loam	A_{1c}	0-8	22	26	10^{x}	
	A_{12}	8-26	19	21	7	
	A_3	26-34	14	20	6	

x Results obtained by sunflower method; other results by pressure membrane method. Determinations made on less than 2 m.m. fraction.

TABLE 14

FIELD MOISTURE CAPACITY, MOISTURE EQUIVALENT, PERMANENT WILTING POINT AND AVAILABLE MOISTURE OF SOME WEST KOOTENAY SOILS

(Percent by weight of oven dry soil)

Soil Type and Horizons		Depth (inches)	Field Capacity	Moisture Equivalent	Permanent Wilting Point	Available Moisture to 3 foot depth
Shoreacres fine sandy loam	A_{1c}	0-6	25	27	10x	1.1
	B	6-20	11	13	4	1.2
	C	20-36	9	6	2	1.4
		0-36				3.7
Shoreacres silt loam	A_{1c}	0-9	24	28	10x	1.3
	B_1	9-12	13	29	9x	0.2
	B_2	12-32	20	35	9x	3.2
	C	32-36	27	32	9	0.9
		0-36				5.6
Krestova sand	B_1	0-4	28	16	7x	0.8
	B_2	4-12	18	11	7	0.6
	C	12-36	9	3	2x	1.7
		0-36				3.1
Krestova coarse sand	A_{1c}	0-6	11	5	3x	0.6
	B	6-14	16	8	4x	1.3
	C	14-36	3	-	1x	0.7
		0-36				2.6
Krestova sandy loam	A_{1c}	0-6		19	7	
	B_1	6-10		11	2	
	B_2	10-18		10	2	
	B_3	18-32		4	2	
Champion gravelly sandy loam	A_{1c}	0-6	14	13	8x	
	B_1	6-12	13	10	6x	
	B_2	12-36	3	2	2x	

x Results obtained by sunflower method; other results by pressure membrane method. Determination made on less than 2 m.m. fraction.

The moisture equivalent determination has been used as an indirect estimate of the field moisture capacity of soils (7), although the results do not always agree (58). From the moisture equivalent results included in Tables 13 and 14 it will be noted that this was the case for a number of the soils tested. In general, in the instances of the finer textured soils, the results approach one another closely, but for the coarse textured soils, the moisture equivalent values are generally lower. These results are in general agreement with the findings of others such as Veighmeyer and Hendrickson(54) and Thorne and Peterson (45). For this study, therefore, it may be concluded that the actual field measurement is a much better estimate of field capacity than is the moisture equivalent.

When considering the results by the two methods it should be noted that for the gravelly soils the moisture equivalent figures given in the tables are based on material of particle size less than 2 mm. in diameter while the field results are based on the whole soil. Also the conditions reported by Colman (10) and others that soils underlain by coarse textured strata retain more moisture than would be expected from a consideration of their texture and content of coarse fragments. This condition appears to exist in some of the soils under study, particularly in the cases of

Danville loamy coarse sand and Champion gravelly sandy loam.

From the figures included in Tables 13 and 14 it is evident that for the soils under study, the moisture equivalent gave a reasonable estimate of field moisture capacity for the fine textured soils when adjustments for the coarse fractions are made. However, in the case of the coarse textured soils, the moisture equivalent underestimates the moisture retained by the soil under field conditions.

The permanent wilting percentages reported in Tables 13 and 14 show a wide range, from a low of 1 percent in the C horizon of Krestova coarse sand to a high of 15 percent in the A_{1c} horizon of Claypit silt loam. When these results are considered in relation to the field moisture capacity and the moisture equivalent values, it will be noted that where those values are high the wilting percentage values are also high. There is, however, no direct relationship between the values. Such authors as Veighmeyer and Hendrickson (54) and Furr and Keene (22) have also found this to be the case.

The total available moisture storage capacity of soil is often taken as the difference between the field moisture capacity and the permanent wilting percentage (45). This was done in the present study and in Tables 13 and 14 the total available water storage capacity of the soils to a 3 foot depth is shown. These values were calculated for each horizon using the expression,

$$d = \frac{(Pfc - Ppwp)\ A_s\ D}{100}$$

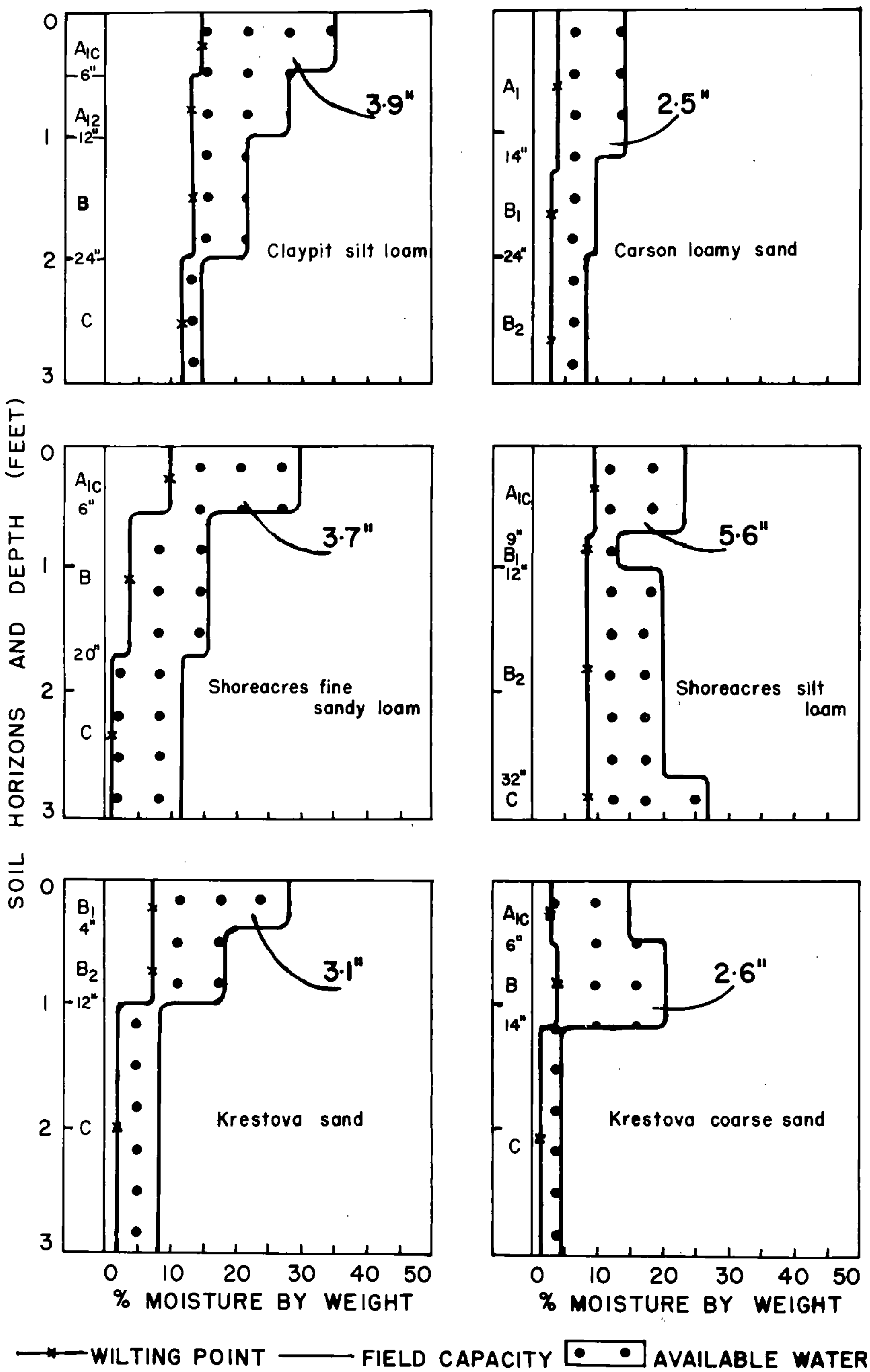
Pfc = field moisture capacity
Ppwp = permanent wilting percentage
A_s = apparent specific gravity
D = depth of soil
d = available moisture storage capacity

The total available moisture storage capacity of a number of the soils to a 3 foot depth is shown graphically in Figure 5. It will be noted that the amount of available water ranges from only 2.5 inches for Carson loamy sand to 5.6 inches for Shoreacres silt loam.

A more complete evaluation of the moisture retaining characteristics of some of the more important soils may be made from a consideration of the data included in Table 15 and shown graphically in Figure 6. In preparing the soil moisture tension curves represented in Figure 6, the data contained in Table 15 was used together with the moisture equivalent and wilting point values.

In constructing soil moisture tension curves the moisture tension expressed as the logarithm of a corresponding column of water in centimeters, that is pF units, is plotted against the percent moisture found in the soil at that tension. The water available to plants

FIGURE 5



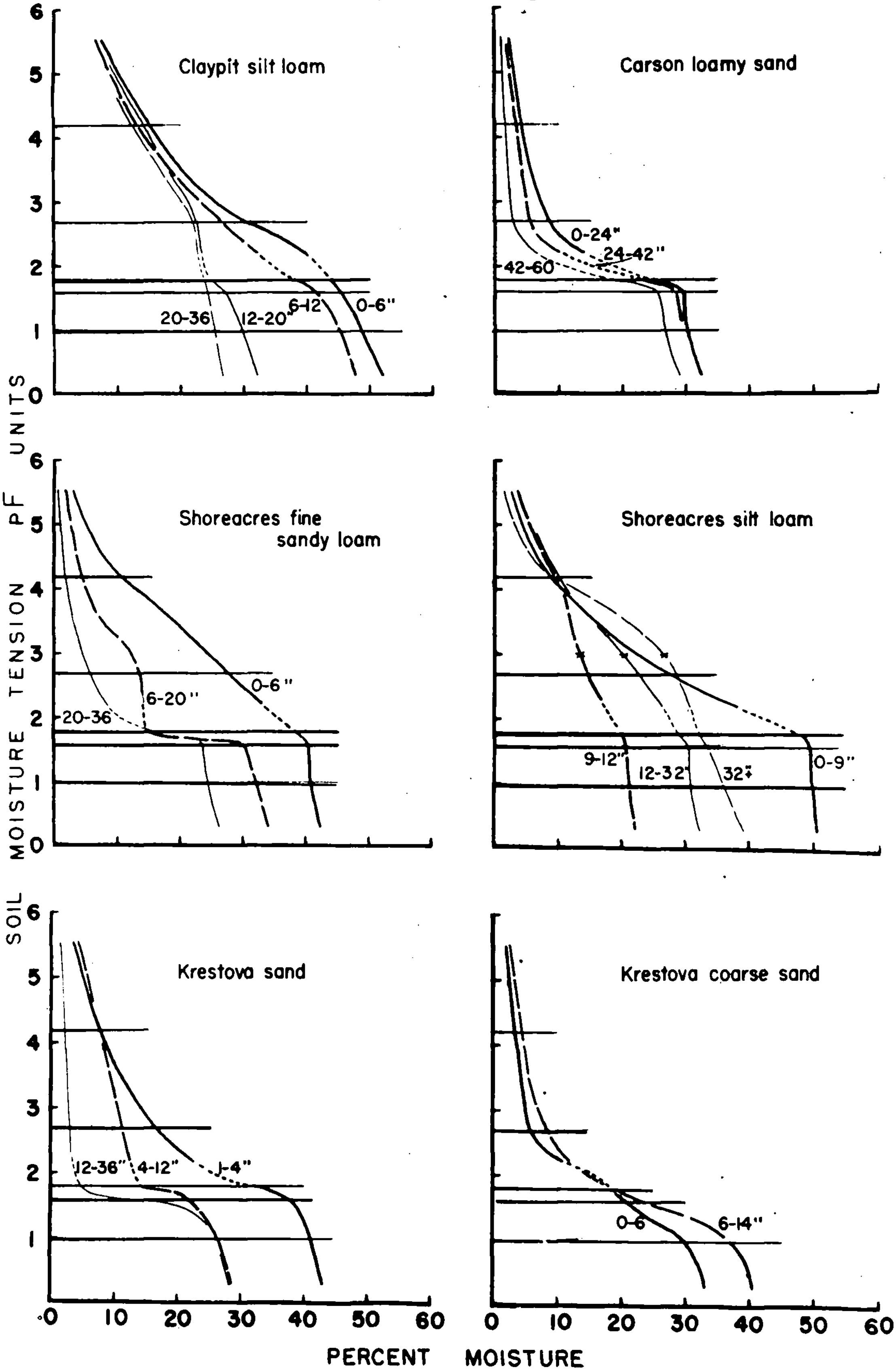
INCHES OF AVAILABLE MOISTURE

may be taken as that part of the soil moisture which lies between the permanent wilting percentage, pF 4.2 and moisture equivalent pF 2.7 (3). Thus, from these curves the percent moisture available to plants can be readily interpreted by observing the gradient of the curve between these two pF values; the steeper the gradient of the curve the lower the percent available moisture.

In general the soil moisture tension curves appear to fall into two groups, those of Carson loamy sand, and Krestova sand and coarse sand that have high gradients and those of Claypit silt loam and Shoreacres fine sandy loam and silt loam that have low gradients in the range of available water.

The inches of available water held to a three foot depth were calculated using field capacity, permanent wilting point and apparent specific gravity data for seven soils of the Doukhobor lands. The results of these calculations are reported in Tables 13 and 14 and for six of the soils studied the results are shown graphically in Figure 6.

FIGURE 6



SOIL MOISTURE TENSION CURVES

TABLE 15

PORE SIZE DISTRIBUTION OF SOME GRAND FORKS AND WEST KOOTENAY SOILS

Soil Type and Horizon		Sample depth	Percent of Total Soil Volume Drained at Tensions Indicated (cm. of water).							
			0-10	10-20	20-40	40-60	60-80	80 to oven dryness	0-40	40 to oven dryness
GRAND FORKS AREA										
Claypit silt loam	A_{1c}	1-4	4.9	1.4	2.0	2.0	1.2	45.7	8.3	47.9
	A_{12}	8-11	3.9	1.5	2.3	2.3	1.7	41.0	7.7	45.0
	B	15-18	3.9	1.9	4.0	1.6	0.6	34.4	9.8	36.6
	C_1	27-30	2.9	1.0	0.9	1.1	0.6	35.3	3.8	36.6
	C	54-57	3.7	1.0	1.6	1.2	0.6	35.1	6.3	36.9
Carson loamy sandy	A_1	3-6	4.5	0.4	0.3	3.8	3.1	33.5	5.2	40.4
	B_1	24-27	5.4	0.8	0.5	2.4	5.2	33.2	6.7	40.9
	B_2	42-45	5.9		1.3				7.2	36.0
Carson sandy loam	A_{1c}	1-4	2.3	0.5	0.4	0.8	0.9	47.1	3.2	48.8
	B	12-15	2.5	0.1	0.4	1.6	1.9	52.7	3.0	56.0
	C	28-31	2.1	0.8	0.6	2.5	1.7	46.6	3.5	50.8
WEST KOOTENAY AREA										
Shoreacres fine sandy loam	A_{1c}	0-3	4.5	1.3	1.6	2.4	1.8	45.0	7.4	49.2
	A_{1c}	2-5	3.1	0.3	0.2	1.5	1.2	45.5	3.6	48.2
	B	10-13	4.4	0.6	0.7	6.6	5.8	21.9	5.7	44.3
	C	28-31	4.9	0.8	0.7	10.7	9.4	19.8	6.4	39.9
Shoreacres silt loam	A_{1c}	1-4	1.4	0.1	0.4	0.7	0.5	50.2	1.9	51.4
	B_1	9-12	2.7	0.4	0.3	0.6	0.5	31.0	3.4	32.1
	B_2	20-23	4.0	0.6	1.0	0.9	0.5	40.8	4.7	43.1
	C	32-35	6.3	0.9	2.5	0.8	0.7	40.3	9.7	41.8
Krestova sand	B_1	1-4	3.2	1.3	2.4	4.0	2.6	41.0	7.6	47.6
	B_2	8-11	4.6	0.6	5.9	7.2	3.6	19.8	11.1	30.4
	C	20-23	4.1	2.9	18.4	5.4	1.8	9.4	25.4	16.6
Krestova coarse sand	A_{1c}	1-4	4.2	4.8	7.5	2.7	0.7	25.3	16.5	28.7
	B	10-13	4.1	8.3	8.14	4.0	2.0	24.6	20.8	30.6

CONCLUSIONS

Most of the soils that occur on the 18,872 acres of Doukhobor lands in the Grand Forks and West Kootenay areas of British Columbia belong to the Black or Brown Podzolic Great Soil Groups. Small areas of Gleizolic soils also occur together with areas of dunes, peat and saline soils.

These soils are developed from a wide variety of transported parent materials, including river alluvium, glacial till and till derivatives and alluvial fans. On the steeper slopes of the mountain sides the soils are very shallow and stony and many outcrops of bare rock occur. In most soils, parent material has played a dominant role in determining soil characteristics.

Chemical analysis showed the Black soils to contain significantly more organic matter and nitrogen, and to have a narrower carbon to nitrogen ratio than the Brown Podzolic soils.

For the most part the soils of the Doukhobor lands are very coarse textured ranging from sand to sandy loam, although in some small areas fine textured soils occur such as loam to clay loam.

The soils containing the highest percentage of clay and silt were generally found to have the lowest percent of macro-pore space and the lowest infiltration rate and hydraulic conductivity values but they were capable of storing the largest amounts of available water.

At the time of the present study about 14 percent of the Doukhobor lands was cultivated regularly and the remaining 86 percent was used for rough pasture or forestry. About 83 percent of the area covered by the soils of the Doukhobor lands was considered non-arable because of coarse texture, steep topography or stoniness. However under irrigation only 42 percent was classed as doubtful for crop production.

APPENDIX

LAND CLASSIFICATION AND RATING

Using the soil survey and laboratory information, the soils of the Doukhobor lands have been classified according to their suitability for crop production with and without irrigation. In arriving at the land classification, the soil factors, such as texture, structure, permeability, water storage capacity, topography, stoniness, about which information was available and which were known to affect the use of the land for crop production were taken into account. However, it should be noted, that, as in the case of most land classifications, a certain amount of personal judgment was necessary both in interpreting the facts collected during the field and laboratory studies and in making assumptions concerning factors about which information was not available.

The land classification system used for classifying the lands for crop production without irrigation, was similar to that used by the Land Utilization Research and Survey Division of the

British Columbia Department of Lands (15) (16) (17). Although some modification was necessary in applying it to the soils of the Doukhobor lands. The system is patterned after that used by the United States Soil Conservation Service as described by Hockensmith (23).

In rating the land for crop production with irrigation, the system described in the British Columbia Land Reclamation Committee Brief Number 22 (13) was followed. This rating system is based on that used in Alberta and Saskatchewan (21) which in turn is patterned after the Storie system used in California.

In a cooperative study, the Land Utilization Research and Survey Division used the land classification to arrive at actual dollar per acre values for the land (18) but this has not been included in the present study. It is believed, that whereas the monetary value of the lands may change, their classification and rating will remain more steady.

Land Classification for General Crops Without Irrigation

Although eight land classes are included in the classification system (17) (18) only seven were used in classifying the Doukhobor lands, no land being placed in Class 4. In the sections that follow the descriptions of the different classes are given along with the soil types andacreages of each of the classes in the Grand Forks and West Kootenay areas. The acreages of each land class are given by communities in Table 16.

Class 1

This is good arable land suitable for general farming and intensive cultivation. It has no permanent limitations. Medium textured Humic Glei and Low Humic Glei soils receiving sufficient moisture by natural sub-irrigation for crop growth are placed in this class. The acreage of Class 1 is very limited and occurs only in the West Kootenay area.

Soil type (Class 1)	Acres	Total Acreage
WEST KOOTENAY AREA		
Claybrick loam	99	
Pass Creek loam	222	321

Class 2

Class 2 land is fair arable land suitable for general farming but having some limitation, such as imperfect drainage in the early season, which affects root development and crop maturity. Some types of the Claybrick and Pass Creek series are rated as Class 2.

TABLE 16

UNIRRIGATED LAND CLASS ACREAGES OF [redacted] DOUKHOBOR LANDS OF BRITISH COLUMBIA[1]

Community	Land Class							
	1	2	3	5	6	7	8	Total
Grand Forks North Sheet			492		1151	94	134	1871
Grand Forks South Sheet			712		1942	110	81	2845
Gilpin			10		414		12	435
Caesar			22		96	40	17	175
Grand Forks Area			1236		3603	244	244	5327
Champion Creek		4			466	84	366	920
Ooteshenie		30	165		2096	677	1032	4000
Brilliant & Raspberry		31	244		81	625	38	1019
Glade			182		400	289	92	963
Shoreacres	21	1	220		85	304		631
Pass Creek	108	53	63		489	1796	81	2590
Krestova	13	89	164		1179	285	355	2085
Koch Siding		32	7		65	17	71	192
Lebahdo	102		58	39	36	79		314
Winlaw	40	17	40	25	30	14	57	223
Claybrick	37	52			212		43	344
Perry Siding		2	26		128	84	24	264
West Kootenay Area	321	311	1169	64	5267	4254	2159	13545
TOTAL	321	311	2405	64	8870	4498	2403	18872

1 Revised from Drewry (18) 1953

Soil Type (Class 2)	Acres	Acreage Total
WEST KOOTENAY AREA		
Claybrick clay loam	36	
Claybrick loamy sand	181	
Pass Creek loamy sand	94	311

Class 3

Arable land with limited usefulness because it becomes too dry for optimum crop growth but is satisfactory for extensive cultivation of cereal and forage crops. Most of the communities have large areas of this class of land.

Soil Type (Class 3)	Acres	Total Acreage
GRAND FORKS AREA		
Claypit silt loam	100	
Claypit loam, level phase	77	
Claypit loam, sloping phase	3	
Boundary loam, level phase	30	
Boundary loam, sloping phase	1	
Carson coarse sandy loam	10	
Carson sandy loam	28	
Hardy loam, level phase	17	
Hardy loam, sloping phase	197	
Hardy gravelly loam, sloping phase	23	
Hardy gravelly loam, moderately steep phase	513	
Granby sandy loam	17	
Granby silt loam	3	
Granby loamy sand	12	
Gibbs gravelly loam	102	
Saline Seepage	103	1236

Soil type (Class 3) (continued)	Acres	Total Acreage
WEST KOOTENAY AREA		
Shoreacres silt loam	414	
Shoreacres fine sandy loam, level phase	453	
Shoreacres fine sandy loam, sloping phase	72	
Claybrick gravelly sandy loam	111	
Glade gravelly loam, level phase	38	
Glade gravelly loam, sloping phase	72	
Glade loam	9	1169
		2405

Class 4

Land that is not suited to regular cultivation because of excessive droughtiness falls into Class 4. It may be described as limited arable suited only for pasture. In the case of the Doukhobor lands soils that might have been included here are included in Class 6.

Class 5

Class 5 land is non-arable because of excessive wetness or some other factor. It is still capable of producing native forage. Two small blocks of peat soil occur in the West Kootenay area, comprising 64 acres of Class 5 land in all.

Class 6

Land rated as Class 6 is unsuitable for cultivation because of excessive drought, unfavourable topography or extreme stoniness. This class included nearly half of the non-arable land which is distributed throughout all the communities. It is mainly suited for grazing or forest production.

Soil type (Class 6)	Acres	Total Acreage
GRAND FORKS AREA		
Carson loamy sand, level phase	161	
Carson loamy sand, windblown phase	62	
Danville loamy coarse sand	201	
Hardy gravelly sandy loam, level phase	17	
Hardy gravelly sandy loam, kettle phase	57	
Hardy stony loam, undifferentiated	1549	
Caesar loamy coarse sand	100	
Caesar fine sand	18	
Rideau Complex	18	
Gibbs gravelly sandy loam, sloping phase	45	
Gibbs gravelly sandy loam, kettle phase	88	
Gibbs stony loam, undifferentiated	1280	
Bottomland	7	3603
WEST KOOTENAY AREA		
Krestova loamy sand	1131	
Krestova sand	1929	
Krestova coarse sand	499	
Champion gravelly sandy loam, non-stony phase	894	
Champion gravelly sandy loam, stony phase	179	
Claybrick gravelly sandy loam, stony phase	37	
Glade gravelly sandy loam, non-stony phase	129	
Glade gravelly sandy loam, stony phase	469	5267
		8870

Class 7

The non-arable, rough mountainous, forested tracts are placed in this class. It may have inclusions of barren rock or wasteland that would be in Class 8 if more detailed separations were made. All communities include large areas of this class, the main use of Class 7 being for forestry. In the Grand Forks and West Kootenay areas there are 244 acres and 4254 acres respectively making a total of 4498 acres of Class 7 land on all the Doukhobor land.

Class 8

In this class are placed non-productive areas such as steep eroded slopes, rock outcrop, sand dunes and any barren areas.

Soil type (Class 8)	Acres	Total Acreage
GRAND FORKS AREA		
Eroded and Dissected land	244	244
WEST KOOTENAY AREA		
Dunes	37	
Eroded and Dissected land	2122	2159
		2403

The total acreages, and the respective percentages, of the land classes of the Grand Forks and West Kootenay areas and of all the Doukhobor lands are summarized below.

TABLE 17

SUMMARY OF ACREAGES AND PERCENTAGES OF LAND CLASSES WITHOUT IRRIGATION

Land Class	Grand Forks		West Kootenay		All Doukhobor Land	
	Total	Percent	Total	Percent	Total	Percent
Class 1, arable	--	--	321	2	321	2
Class 2, arable	--	--	311	2	311	2
Class 3, arable	1236	24	1169	9	2405	13
Class 4, non-arable	--	--	--	--	--	--
Class 5, non-arable	--	--	64	0	64	0
Class 6, non-arable	3603	66	5267	39	8870	47
Class 7, non-arable	244	5	4254	32	4498	23
Class 8, non-arable	244	5	2159	16	2403	13
TOTAL	5327	100	13545	100	18872	100

From the summary of land classes in Table 17, it will be noted that, for the Grand Forks area, 1,236 acres or 24 percent of the area has been classed as suitable for cultivation without irrigation but that it is placed in the lowest category, or Class 3. In the West Kootenay area, the acreage of soil suitable for cultivation without irrigation was found to amount to 1,801 acres or 13 percent of the area. For the Doukhobor lands as a whole, the acreage of arable soils was found to be 3,037 acres or 17 percent and that 13 percent of this was placed in Class 3.

Reference to Table 17 also shows that the largest acreage of soils in both the Grand Forks and West Kootenay areas, a total of 8870 acres or 47 percent was placed in Class 6. Soils of this class are thought to be best suited to grazing or timber production or a combination of the two.

Land Classification for General Crops with Sprinkler Irrigation

A further general classification of the soils was made on the basis of suitability for cultivation with sprinkler irrigation (18). In this case, three classes of soil suitable for irrigation were used, and the remaining soils considered unsuitable for cultivation with sprinkler irrigation were all placed in a fourth class. A brief description of these classes and the acreages of soil included in each is given below. The acreages of each land class are listed by communities in Table 18.

Class 1

This class is comprised of good land suited to intensive cropping under field irrigation and includes the well drained soils of medium texture having no limitations for cropping. Areas of this class occur at each community and in most instances water is available to irrigate them.

TABLE 18

IRRIGATED LAND CLASS ACREAGES OF [redacted] DOUKHOBOR LANDS OF BRITISH COLUMBIA[1]

Community	Land Class				
	1	2	3	Unclassified	Total
Grand Forks North Sheet	163	273	186	1249	1871
Grand Forks South Sheet	323	628	117	1777	2845
Gilpin	10	18	29	379	436
Caesar	10	12	89	64	175
Grand Forks Area	506	931	421	3469	5327
Champion Creek		95	212	613	920
Ooteshenie	165	1259	827	1750	4000
Brilliant & Raspberry	244	91	3	681	1019
Glade	117	226	109	511	963
Shoreacres	241	1	81	308	631
Pass Creek	63	315		2212	2590
Krestova	177	1057	130	721	2085
Koch Siding		39	8	145	192
Lebahdo	94	14		206	314
Winlaw	40	26	13	145	223
Claybrick	29	224	1	90	344
Perry Siding	26	94	9	137	264
West Kootenay Area	1196	3441	1393	7515	13545
TOTAL	1702	4372	1814	10984	18872

1 Revised from Drewry (18) 1953

Soil type (Class 1)	Acres	Total Acreage
GRAND FORKS AREA		
Claypit silt loam	100	
Claypit loam, level phase	77	
Claypit loam, sloping phase	3	
Boundary loam, level phase	30	
Boundary loam, sloping phase	1	
Carson coarse sandy loam	10	
Carson sandy loam	28	
Hardy loam, level phase	17	
Hardy loam, sloping phase	197	
Hardy gravelly loam, sloping phase	23	
Granby sandy loam	17	
Granby silt loam	3	506
WEST KOOTENAY AREA		
Shoreacres silt loam	414	
Shoreacres fine sandy loam, level phase	453	
Shoreacres fine sandy loam, sloping phase	72	
Claybrick loam	99	
Claybrick gravelly sandy loam	111	
Glade gravelly loam, gently sloping phase	38	
Glade loam	9	1196
		1702

Class 2

Land suited to irrigation but having some limitations such as coarse texture or unfavorable topography is placed in this class. It contains the largest acreage of soil classed as irrigable, but it is likely that lack of water and high development costs would prevent a considerable portion of this land from being irrigated, in the near future at least.

Soil type (Class 2)	Acres	Total Acreage
GRAND FORKS AREA		
Carson loamy sand, level phase	161	
Carson loamy sand, windblown phase	62	
Hardy gravelly loam, moderately steep phase	513	
Hardy gravelly sandy loam, level phase	17	
Granby loamy sand	12	
Gibbs gravelly sandy loam, sloping phase	45	
Rideau Complex	18	
Saline Seepage	103	931
WEST KOOTENAY AREA		
Krestova loamy sand	1131	
Krestova sand	1928	
Claybrick loamy sand	181	
Glade gravelly loam, sloping phase	72	
Glade gravelly sandy loam, sloping phase	129	3441
		4372

Class 3

Land in this class is poorly suited to irrigation except under special circumstances where water may be cheaply available or where the land is strategically located. Where required, land of this class could be used for homesites. Limitations to crop production may consist of hilly topography, excessive drainage or stoniness.

Soil type (Class 3)	Acres	Total Acreage
GRAND FORKS AREA		
Danville loamy coarse sand	201	
Caesar loamy coarse sand	100	
Caesar fine sand	18	
Gibbs gravelly loam	102	421

Soil type (Class 3) (continued)	Acres	Total Acreage
WEST KOOTENAY AREA		
Krestova coarse sand	499	
Champion gravelly sandy loam, stony phase	894	1393
		1814

Unclassified

Soils that do not require irrigation because of natural sub-irrigation or because of definite unsuitability for cultivation have not been considered in the classification with irrigation and are included in the unclassified category.

Soil type (Unclassified)	Acres	Total Acreage
GRAND FORKS AREA		
Hardy gravelly sandy loam, kettle phase	57	
Hardy stony loam, undifferentiated	1549	
Gibbs gravelly sandy loam, kettle phase	88	
Gibbs stony loam, undifferentiated	1280	
Bottomland	7	
Eroded and Dissected	244	
Rough Mountainous	244	3469
WEST KOOTENAY AREA		
Champion gravelly sandy loam, stony phase	179	
Claybrick clay loam	36	
Claybrick gravelly sandy loam, stony phase	37	
Pass creek loam	222	
Pass creek loamy sand	94	
Glade gravelly sandy loam, stony phase	469	
Peat	64	
Dune	37	
Eroded and Dissected	2123	
Rough Mountainous	4254	7515
		10984

Soil Rating for General Crops with Sprinkler Irrigation

A more complete classification or rating of the soils for cultivation with sprinkler irrigation was made using the soil rating method described in Brief Number 22 of the British Columbia Land Reclamation Committee (13). This rating system takes into consideration such soil factors as texture, salinity, topography, stoniness, erosion and drainage. Each factor is evaluated separately and then the evaluations are multiplied together to give a final rating. The final rating is used to group the soils into five main classes as follows.

Group	Description	Rating
1	Very good	100-71
2	Good	70-55
3	Fair	54-40
4	Fair to poor	39-20
5	Doubtful	19-0

The index ratings and soil groups for the soils of all the Doukhobor lands are given in Table 19.

Group 1 soils fit well with the description given in Brief Number 22 (13). They have textures of sandy loam or heavier, a good topography, and very few stones.

The Group 2 soils are rated lower because of coarse texture or sloping topography.

Shoreacres silt loam is rated as Group 3

TABLE 19

RATINGS AND CLASSIFICATION OF SOILS

OF DOUKHOBOR LANDS FOR IRRIGATION

Soil type and Phase	Texture	Salinity	Topography	Stoniness	Erosion	Drainage	Rating	Class
Boundary loam, level	90	100	100	97	95	100	83	1
Boundary loam, sloping	90	100	90	97	90	100	71	1
Carson loamy sand, level	35	100	95	100	100	100	33	4
Carson loamy sand, windblown	35	100	75	100	100	100	26	4
Carson coarse sandy loam	70	100	100	100	100	100	70	2
Carson sandy loam	70	100	90	100	95	100	60	2
Caesar loamy coarse sand	35	100	60	100	90	100	19	5
Caesar fine sand	45	100	90	100	90	100	37	4
Champion gravelly sandy loam, non-stony	55	100	95	95	95	100	47	3
Champion gravelly sand, stony	55	100	95	50	95	100	25	4
Claybrick loam	95	100	95	100	95	100	86	1
Claybrick clay loam	90	100	95	100	95	90	73	1
Claybrick loamy sand	45	100	95	100	95	100	41	3
Claybrick gravelly sandy loam non-stony	60	100	95	90	95	100	49	3
Claybrick gravelly sandy loam, stony	60	100	95	50	95	100	27	4
Claypit silt loam	100	100	95	100	95	90	81	1
Claypit loam, level	95	100	100	100	95	95	86	1
Claypit loam, sloping	95	100	90	100	95	95	77	1
Danville loamy coarse sand	30	100	100	96	94	100	27	4
Dune	25	100	80	100	50	100	10	5
Gibbs gravelly loam	85	100	60	90	95	100	44	3
Gibbs gravelly sandy loam, sloping	70	100	70	90	95	100	42	3
Gibbs gravelly sandy loam, kettle	55	100	25	90	90	100	11	5
Gibbs stony loam, undifferentiated	80	100	40	90	95	100	27	4

TABLE 19 (continued)

Soil type and Phase	Texture	Salinity	Topography	Stoniness	Erosion	Drainage	Rating	Class
Glade gravelly loam, level	90	100	95	95	95	100	77	1
Glade gravelly loam, sloping	90	100	80	90	90	100	58	2
Glade loam	95	100	95	100	95	100	86	1
Glade gravelly sandy loam, non-stony	65	100	95	95	95	100	56	2
Glade gravelly sandy loam, stony	65	100	95	40	95	100	23	4
Granby sandy loam	60	100	100	100	95	100	57	2
Granby silt loam	95	100	95	100	90	95	77	1
Granby loamy sand	40	100	100	100	90	80	29	4
Hardy loam, level	95	100	100	100	95	95	86	1
Hardy loam, sloping	95	100	80	100	90	100	68	2
Hardy gravelly loam, sloping	90	100	70	100	90	100	57	2
Hardy gravelly loam, moderately steep	90	100	40	95	90	100	31	4
Hardy gravelly sandy loam, level	60	100	95	95	95	100	51	3
Hardy gravelly sandy loam, kettle	60	100	25	95	90	100	13	5
Hardy stony loam, undifferentiated	90	100	40	90	95	100	31	4
Krestova loamy sand	30	100	95	100	95	100	27	4
Krestova sand	25	100	95	100	95	100	23	4
Krestova coarse sand	20	100	95	100	95	100	18	5
Pass Creek loam	95	100	95	100	100	90	81	1
Pass Creek loamy sand	50	100	95	100	100	90	43	3
Rideau Complex	50	100	60	85	90	100	23	4
Saline Seepage	60	50	80	90	100	75	16	5
Shoreacres silt loam	75	100	95	100	95	80	54	3
Shoreacres fine sandy loam, level	80	100	95	100	95	100	72	2
Shoreacres fine sandy loam, sloping	80	100	80	100	95	100	61	2

because of its impervious subsoil which restricts drainage. Pass Creek loam has been placed in the third group because of poor drainage due to a high water table in the early season. Other Group 3 soils have a coarser texture or are more stony than Group 2 soils.

The very coarse textured soils and the stony soils fall into Group 4. Pass Creek loamy sand, the saline seepage soils and the moderately steep phase of Hardy gravelly loam are also rated Group 4.

Group 5 soils have serious limitations such as poor topography, excessive stoniness or poor drainage. Included in Group 5 are the kettle phases, areas of bottomlands, peat and dunes. Krestova coarse sand was also placed in Group 5 because of its extremely coarse texture.

The total acreages, and the respective percentages, of all the soil groups of the Grand Forks and West Kootenay areas and of all the Doukhobor lands are summarized below.

TABLE 20

SUMMARY OF ACREAGES AND PERCENTAGES SOIL RATINGS FOR CROPS WITH SPRINKLER IRRIGATION

Soil Group Rating	Grand Forks Total	Grand Forks Percent	West Kootenay Total	West Kootenay Percent	All Doukhobor Land Total	All Doukhobor Land Percent
Group 1	231	4	404	3	635	3
Group 2	275	5	726	5	1001	5
Group 3	164	3	1694	13	1858	10
Group 4	3814	72	3745	28	7559	40
Group 5[1]	843	16	6976	51	7819	42
TOTAL	5327	100	13545	100	18872	100

1 Includes Eroded and Dissected, and Rough Mountainous Lands, Bottomlands and Peat.

From the foregoing summary it will be noted that there is an extremely low percentage, 3 percent, of Group 1 or very good soil on all Doukhobor lands and likewise the percentage of Groups 2 and 3, good to fair, soils is low, 15 percent, on all Doukhobor lands. A large part of the Group 4 or fair to poor soil, could be used with sprinkler irrigation and in the Grand Forks area this constitutes 72 percent.

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