SOILS REPORT No. 10 1959

SOIL SURVEY

OF A CROSS-SECTION THROUGH THE

UPPER NELSON RIVER BASIN

ALONG THE HUDSON BAY RAILWAY IN

NORTHERN MANITOBA

By

W. A. EHRLICH, L. E. PRATT
J. A. BARR AND F. P. LECLAIRE

MANITOBA SOIL SURVEY

CANADA DEPARTMENT *of* AGRICULTURE,
MANITOBA DEPARTMENT *of* AGRICULTURE AND CONSERVATION,
LANDS BRANCH, MANITOBA DEPARTMENT *of* MINES AND NATURAL RESOURCES
AND SOILS DEPARTMENT, THE UNIVERSITY *of* MANITOBA.

Report published by the Manitoba Department of Agriculture and Conservation.
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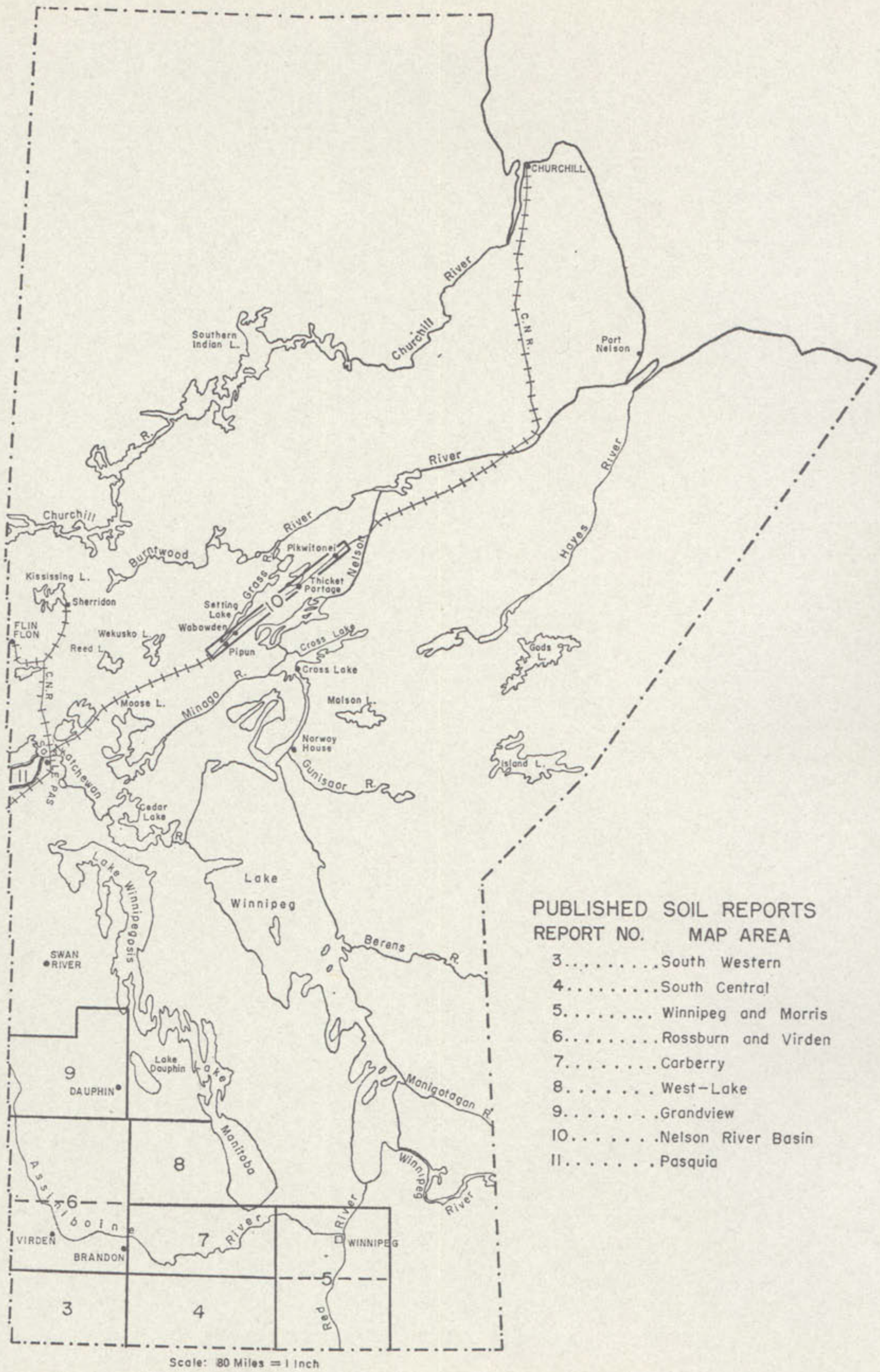

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3	South Western
4	South Central
5	Winnipeg and Morris
6	Rossburn and Virden
7	Carberry
8	West-Lake
9	Grandview
10	Nelson River Basin
11	Pasquia

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Summary

THIS SOIL SURVEY of a cross-section through the Upper Nelson River Basin covers an area of approximately 875 square miles in a tract of land bordering the Hudson's Bay Railway. The surveyed strip extends along the railway line from Kiski Creek at Mile 114 to Armstrong Lake at Mile 220. It traverses the main area of clay deposits in this northern extremity of the glacial Lake Agassiz basin. This "northern clay area" extends northward from Lake Winnipeg to the vicinity of Nelson House, near the 56th parallel, and covers an area of approximately 11,000 square miles. This is not a clay plain in the same sense as the flat Red River Plain in Southern Manitoba, but rather is a region of irregular, gently to moderately sloping topography in which clay areas are interspersed in a complex landscape pattern with large expanses of "muskeg", sharp bosses of granitic rock and a multitude of lakes. Within the surveyed section, 31 percent of the land consists of clay deposits with imperfect to good drainage, 52 percent is very poorly drained peat land, 3 percent is rock outcrop and 14 percent is covered by water. These proportions vary in other parts of the clay region and it is estimated that only 20 percent of the total area consists of better-drained, clay soils.

The climate of this northern clay area is sub-humid with most of the precipitation falling as rain during the summer months. The average yearly precipitation at Wabowden for the period 1945 to 1957 was 17.63 inches. Mean monthly temperatures are 5 to 10 degrees lower than at Winnipeg, with a mean annual temperature at Wabowden of 27.9°F (compared with 35.4°F at Winnipeg). The average frost-free period at Wabowden over the last 12 years has been 90 days, although it has ranged from 68 days in 1945 to 109 days in 1953. The average vegetative period during this interval was 118 days. This climatic regime has produced a Boreal forest vegetation. Spruce is the dominant tree species throughout the region. White spruce is associated with some aspen, jack pine and birch on the uplands, and black spruce forms an association with tamarack in the swampy areas.

The upland soils within the surveyed area consist almost entirely of Solonetzic Grey Wooded soils developed on lacustrine clay. These soils were classified as the Wabowden series. Other well to imperfectly drained soils that occupy very small areas are: Orthic Grey Wooded soils on lacustrine clay and silt deposits, and Podzol soils on lacustrine sand deposits. The swamp areas consist of Bog and Half Bog soils, with the deeper peat deposits being predominant.

Any future agricultural development in this northern clay area will face many serious problems. The frost-free period is marginal for the production of present varieties of wheat and coarse grains. The percentage of readily arable land per quarter section is low and the reclamation of peat land would be difficult and expensive. The better drained, clay soils are strongly leached and would require large applications of nitrogen and phosphate fertilizers for grain and forage production. However, coarse grains, forage crops and some vegetables have been grown successfully on the Wabowden Experimental Substation, where experimentation with varieties and fertilizers is being conducted.

Introduction

A RECONNAISSANCE SOIL SURVEY was conducted in the clay area along the Hudson Bay Railway for the purpose of obtaining information on the nature of the soils and estimating the acreage of potential agricultural land in the area. Approximately 275,000 acres were covered by reconnaissance survey and about 285,000 acres were added to the mapped area through interpretation of aerial photographs. The surveyed portion cuts diagonally across the clay area in the Upper Nelson River Basin, which extends from the northern tip of Lake Winnipeg at latitude N.53°51′ northward to the vicinity of the 56th parallel. This clay area covers approximately 7,000,000 acres which is only a small portion of the area in the northern section originally covered by glacial Lake Agassiz. Clay deposits outside of the designated clay covered region, but within the original strand lines of Lake Agassiz, occur only in small scattered areas.

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PART I

GENERAL DESCRIPTION OF AREA

A. HISTORICAL

Early Explorations and Settlements

The history of white-man's discovery and exploration of the region that is now northern Manitoba far pre-dates his conquest and development of the southern prairies. Henry Hudson's ill-fated voyage of 1611 into the vast inland bay that bears his name, in search of the elusive North-West Passage, marked the beginning of an era of exploration that opened our northland and provided access to this southern region. Many of the men who braved the unknown in those early days to charter waterways, explore territories, build forts and trading posts and establish settlements are commemorated in the names that dot the map of Northern Manitoba. Some of the names that have been used to designate soil series in this report have such a historic background.

The earliest adventurers into Hudson Bay were all concerned with the arduous search for a North-West passage to the seas of the south. Sir Thomas Button and his sailing master Francis Nelson were forced to over-winter at the mouth of the Nelson River; as was Jens Munk's Danish company at the mouth of the Churchill River. Captains Luke Foxe and Thomas James also sailed in this search and their reports greatly stimulated the next stage in this epic of discovery.

With the fading of hopes for the long-sought passageway came a new incentive for adventure —the fur trade. Zachariah Gillam's highly successful voyage of 1668 to barter trade goods with the Indians for furs moved King Charles the Second to grant a Royal Charter to "The Governor and Company of Adventurers of England trading into Hudson's Bay". This charter, in effect from 1670 to 1870, gave the Company of Adventurers—forerunners to the Hudson's Bay Company—exclusive fur trading rights, as well as other privileges, over the vast area draining into Hudson Bay, then called Rupert's Land. The immediate result was the erection of trading posts along the shore of Hudson's Bay—Charles Fort, Hayes Island and Albany Factory at the south end, and Port Nelson and York Factory at the mouth of the

NOTE: The information contained in the Historical section of this report was abstracted from, "The Hudson's Bay Route" by A. M. Pratt and J. H. Archer, Governments of Manitoba and Saskatchewan, 1953.

Hayes and Nelson rivers. From these ports, particularly York Factory, was later to come the journeys inland and the first breach of the unknown West.

The adventurous trip of young Henry Kelsey, who journeyed to the land of the Asinoe Poets (Assiniboine Indians) in 1691-92 and reached the present location of Swan River, was of immense importance to the opening of this vast territory. The next hundred years saw the expansion of the fur trade over the Canadian West. The invasion of the territory by the "Bourgeois du Nord-Ouest" from Quebec compelled the English to expand their activities inland and rival trading posts were soon established throughout the northern and prairie regions. This period includes the explorations of such men as Sieur de la Vérendrye and his sons, Anthony Hendry and Samuel Hearne. It saw the beginnings of Winnipeg (Fort Rouge), Brandon (Brandon House and Assiniboine House), Virden (Montagne a la Bosse Fort), Dauphin (Fort Dauphin), and Le Pas (Fort Poskoia, or Basquia). And by the end of this 18th century the original "Hudson's Bay Route" to the prairies had been established.

This "old route"—from York Factory up the Hayes and Nelson rivers to Lake Winnipeg —is of great historic importance to the area concerned in this report, for it was the memory of this traditional passageway that first spurred the agitation for a modern "iron route" to Hudson's Bay. Also, one of the area's largest settlements, Norway House, was first built in 1812-13 by a group of Norwegians hired by the Company of Adventurers to construct a road which would avoid the many rapids and portages between the Lake and the navigable portion of the Hayes River. It was later rebuilt in 1825 as the headquarters of the Northern Department of Rupert's Land. And, after the importance of the "old route" had been ended by the arrival in Winnipeg in 1877 of the first locomotive, the "Countess of Dufferin", Norway House began its present role as the northern centre for the administration of health and welfare services, as a trading post, school site, police establishment and forestry station, and as the commercial centre for a large portion of northern Manitoba.

The Hudson Bay Railway

With the coming of the trans-Canada railway and the changing of the Canadian West from a frontier region of Indians and fur-traders to a gigantic producer of hard red wheat, the old Hudson Bay route died. The era of sailing ships and York boats was over and modern transportation was required in ever-increasing volume to market the products of the farms and bring goods to the growing population of the west. But the old historic route was still large in man's minds and anxiety over export difficulties soon led to a new look to the north. As early as 1878, Henry Hind presented a brief urging the building of a railway to "The Bay" before a House of Commons Committee. The federal government viewed the project with favour and made a standing offer, from the year 1886 to the year 1908, of a land grant to anyone who would build such a railway.

The offer was never awarded and was withdrawn in 1908 when, after long years of work by promoters of the route, Sir Wilfred Laurier announced that the federal government would build the railway with funds obtained from land sales in the west. The first sod was turned in 1910 at Le Pas and actual construction of the road commenced in the early fall of 1911. Many difficulties and delays were to be encountered before this new Hudson's Bay route would become a reality. By 1918, the tracks had been laid to Kettle Rapids (Mile 332) and grading was completed to Port Nelson. Some harbour installations had been started at Port Nelson and the dream was nearing fulfilment. When, owing to the financial difficulties brought about by the war, the work was abruptly stopped.

By this time, the solitude of the north had been breached by a new type of settlement. Just as the historic forts dotted the "old route", and later became centres for schools, missions, police attachments, forestry stations and trade, so did the rail centres along this new route to the Bay. Many have remained as lone section houses nestled in small clearings of the Boreal forest and proudly bearing the names of the early adventurers of the North-Button, Clarke, Medard, La Perouse, Munk, and so forth. Others have expanded and became the commercial and social centres of the area. Such are Wabowden, Thicket Portage and Pikwitonei in the area of this report. Rail service to these settlements was maintained after the stoppage of track work in 1918, but their main purpose for existence awaited the completion of the route.

Thus things remained through the post-war years and the economic recession of the early twenties. But, an Order-in-Council approving the removal of steel rails from the railway beyond Mile 214 for use elsewhere met with violent protest on the prairies and the demands for action were renewed. By 1925 the rising tide of support for the project and the return of more prosperous times spurred the government's decision to complete the job. However, doubts had arisen as to the best terminal for the line. Earlier investigations had resulted in the selection of Port Nelson over the more northern location of Churchill. But a reappraisal by Sir Frederick Palmer, an eminent authority on port construction, clearly favored the Churchill site. So it was decided, in 1927, to divert the route from its original course and build on to Port Churchill.

Finally on April 3, 1929 the "new route" was completed, and on September 19 a souvenir shipment of 1,800 pounds of wheat was despatched from Churchill on the S.S. Ungava for England. Harbour facilities were constructed during the early thirties, but first the depression and then the war further delayed use of the route as a major outlet for export grain. It was not until 1946 that the Hudson's Bay Route started to prove its importance as a trade route from the Canadian West. Since then, grain shipments and imports have climbed steadily year by year. And now, with the rapid development of mining in northern Manitoba, this railway has fully assumed the importance to northern development that the "old route" once held for the settlement of the prairies.

The Clay Belt

Explorations in northern Manitoba, dating back to the latter part of the nineteenth century, revealed the presence of a large clay belt. Prior to the construction of the Hudson Bay Railroad, the investigations in a large measure were concerned with natural resources other than agricultural land for settlement. Several geological parties traversed portions of the northern part of the province but, due to the relative inaccessibility of the country, the routes travelled were along streams and lakes.

In 1896 Tyrrell et al,* noted a clay deposit of lacustral origin along the Minago and Burntwood rivers. A report presented by McInnes** in 1913, stated "that large tracts of land aggregating several million acres are well suited for agriculture". Johnston*** made a soil survey along the railroad shortly after train service commenced and reported that 65 percent of the surface land along the railroad between Mile 130 and Mile 230 is naturally drained with little or no moss.

These early reports stimulated a group of soil specialists,† in 1952, to investigate the region to determine its agricultural possibilities. The investigation revealed that the area originally designated as the "Northern Clay Belt" contained about 1,500,000 acres of arable land, the arable acreage being about 20 percent of the total area. On the basis of investigations carried out by the Canada Department of Agriculture from 1925 to 1930, and on the evidence given by local inhabitants of the

*Tyrrell, J. Burr, and D. B. Dowling. Reports on the northeastern portion of the District of Saskatchewan and adjacent parts of the districts of Athabaska and Keewatin. Geological Survey of Canada Annual Report, Vol. XIII, 2 p. 25-31FF., 1902.

**McInnes, William. The basins of Nelson and Churchill rivers. Canada Department of Mines Geological Survey. Memoir No. 30, p. 20-27, 1913.

***Johnston, W. A. Reconnaissance soil survey of the area along the Hudson Bay Railroad. Summary report, Geological Survey of Canada, 1912-1922, part D, p. 25-36D, 1917.

†W. A. Ehrlich, E. A. Poyser, Canada Department of Agriculture, J. A. Barr, Manitoba Lands Branch and J. M. Parker, Manitoba Soils and Crops Branch.

success in growing various crops, it was recommended by the investigating group that an experimental station should be established in the clay region to obtain information on the production of grain, forage and vegetable crops. In 1953 the establishment of an Experimental Sub-Station in the area was authorized by the Canada Department of Agriculture. In 1954 a site was selected one-half mile west of the Wabowden railway station. This experimental farm now has 60 acres under cultivation and is testing the adaptability of grain, forage crop and vegetable varieties and the fertilizer requirements of these crops.

These preliminary investigations and the establishment of the Experimental Sub-Station at Wabowden influenced the Manitoba Soil Survey to conduct a more detailed study of the soils in this northern area. The results of this study, carried on in the summer of 1957, are contained in this report.

B. LOCATION AND EXTENT

The soil survey of a cross-section through the Upper Nelson River Basin along the Hudson Bay Railway in northern Manitoba covers an area of approximately 560,000 acres. About 275,000 acres were mapped through soil examinations along foot traverses off the railway track, and the other 285,000 acres were added to the mapped area through interpretation of aerial photographs. The surveyed strip extends from Kiski Creek, at Mile 114 of the Hudson's Bay Railway, to the vicinity of Armstrong Lake, at Mile 220. This strip represents a cross-section through the clay area in the Upper Nelson River Basin. The total clay area, of some 11,000 square miles, extends northward from Lake Winnipeg at latitude N.53°51′ to the vicinity of the 56th parallel. The location of this area of clay deposits is shown in Figure 6.

C. TRANSPORTATION AND SETTLEMENTS

The Hudson Bay Railway, with its spur line from Sipiwesk to the new mining town of Thompson, is the principal transportation route in the northern clay area. Roads are restricted to the vicinity of the larger settlements. Travel within the area, away from the railway lines, is mainly by small aircraft equipped with floats. These aircraft utilize the many lakes within the area as landing sites and have their principal bases at Thicket Portage, Wabowden and Le Pas. Tractor trains were used during the winter of 1956-57 to transport supplies and equipment from Thicket Portage to the Thompson mining project. A road from Simon House on No. 10 Highway to Thompson is presently under construction.

The principal settlements within the area and their populations, according to the 1956 Census of Canada, are listed below:

NORWAY HOUSE	447
WABOWDEN	284
THICKET PORTAGE	228
CROSS LAKE	149
PIKWITONEI	84
NELSON HOUSE	47

Norway House is located on Little Playgreen Lake, a part of the Nelson River system, about 25 miles north of Warren's Landing (old site of Norway House) at the north end of Lake Winnipeg. It is the northern centre for the administration of health and welfare services, and is the site of a large modern hospital. Also situated here are schools, two missions, stores and trading posts, a hotel, police detachment and forestry station.

Wabowden, Thicket Portage and Pikwitonei are railway centres on the Hudson's Bay Railway. Wabowden is located at the western edge of the surveyed section at Mile 136.5, and is in Township 68, Range 8 west of the Principal Meridian. This village is one of the main settlements between Le Pas and Churchill. It is served by three stores, two restaurants, a hotel, churches and a school. The Royal Canadian Mounted Police detachment services a very extensive area from their station at Wabowden. An Agricultural Experimental Sub-Station was established here in 1954. A forestry station and a fishery are also located in the Wabowden area. Thicket Portage is situated at Mile 184 in Township 73, Range 2 west of the Principal Meridian. This settlement has a forestry station, hotel, two stores, church and a school. It enjoyed a brief boom period from 1955 to 1957 as the supply centre for the mining development at Thompson, when as many as seven separate airline companies were operating from here. Pikwitonei is a smaller settlement located at Mile 213 in Township 76, Range 2 east of the Principal Meridian. Its 84 inhabitants are mainly Indians dependent on fur-bearing animals for their livelihood. The village has a store, school and railway water tank and coal chute.

Cross Lake is the site of a large Catholic Mission and is the trading centre for an Indian Reserve. The mission has 50 acres of land under cultivation and grows its own vegetables and livestock feed. There are stores, a school and forestry station located in the village.

Nelson House is situated on Footprint Lake at the northern extremity of the clay area. It is the trading centre for an Indian Reserve and has two missions, a store and a school.

The most recent settlement to be established in this northern area is the mining town of Thompson. With the development of the nickel mines in the Moak-Mystery lakes area, Thompson is expected to grow rapidly to become a town of several thousand inhabitants. It is situated at the Burntwood River at the north-eastern edge of the clay area and is connected with the Hudson's Bay railway line by a spur line from Sipiwesk. As this settlement expands it will become the dominant centre in the area and should provide a local market for some agricultural produce. This mining centre and those to be developed at Chisel, Ghost and Stall lakes will be served by a 375,000 horse power hydro-electric plant at Kelsey which will be partially completed and operating by 1960. This plant is located at Grand Rapids on the Nelson River about 50 miles east of Thompson. Other power plants to be developed at Grand Rapids on the Saskatchewan River and at Whitemud Falls on the Nelson River will "hook-up" with the Kelsey plant and provide power for northern Manitoba.

FIGURE 1

Hudson'Bay Company store at Nelson House—typical of the Company's stores in the villages of the clay area.

FIGURE 2

Cross Lake Mission with vegetable garden in foreground.

FIGURE 3

Light sea plane at Thicket Portage. This aircraft is typical of those used for transportation in the northern clay area.

FIGURE 4

The Hudson Bay railway track through an area of moderately well drained land in the northern clay belt.

D. GEOLOGY OF THE UNDERLYING ROCKS

The rock formations of northern Manitoba are shown in Figure 5. This northern area is divided naturally into three distinct regions: (i) the Pre-Cambrian Shield, consisting of granitoid rocks of the Archean and Proterozoic eras; (ii) the Hudson Bay Lowland, underlain by Paleozoic limestones of the Ordovician and Silurian periods; and (iii) the Manitoba Lowland which, in this northern extremity, is underlain by Paleozoic limestones of the Ordovician, Silurian and Devonian periods.

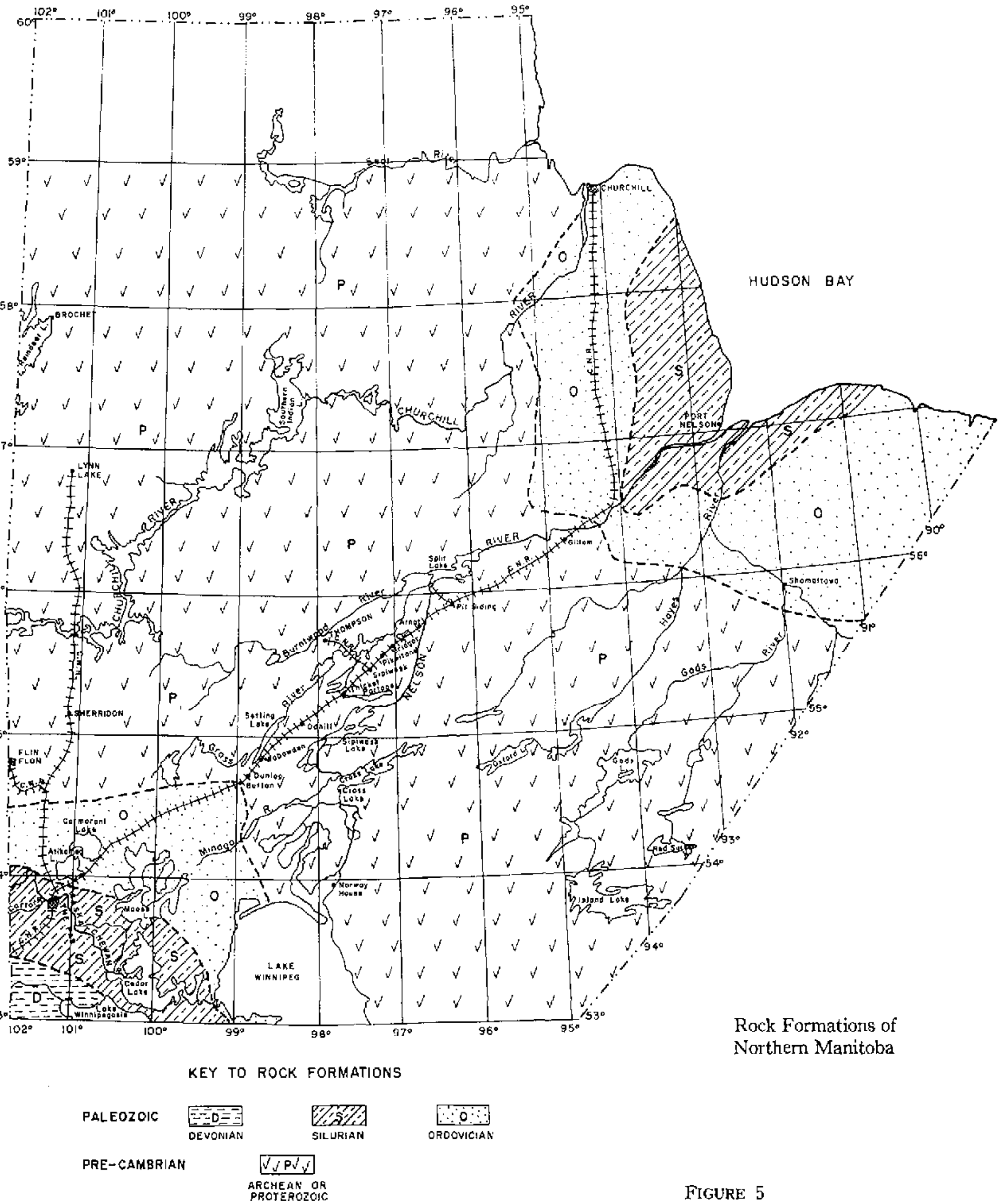
The clay area in the Upper Nelson River Basin lies entirely within the Pre-Cambrian Shield. Outcrops of the granitoid rocks are common throughout the clay belt, although they constitute less than 3 percent of the area within the surveyed section. In other portions of the clay belt, particularly to the north-east of Wabowden and in the vicinity of Armstrong Lake, the area of exposed rock is much greater.

E. SURFACE DEPOSITS

The general distribution of different types of mineral surface deposits in northern Manitoba is shown in Figure 6. These unconsolidated mineral deposits are not continuous over the entire areas shown, but are interspersed with bare rock outcrops and organic deposits of peat and muck.

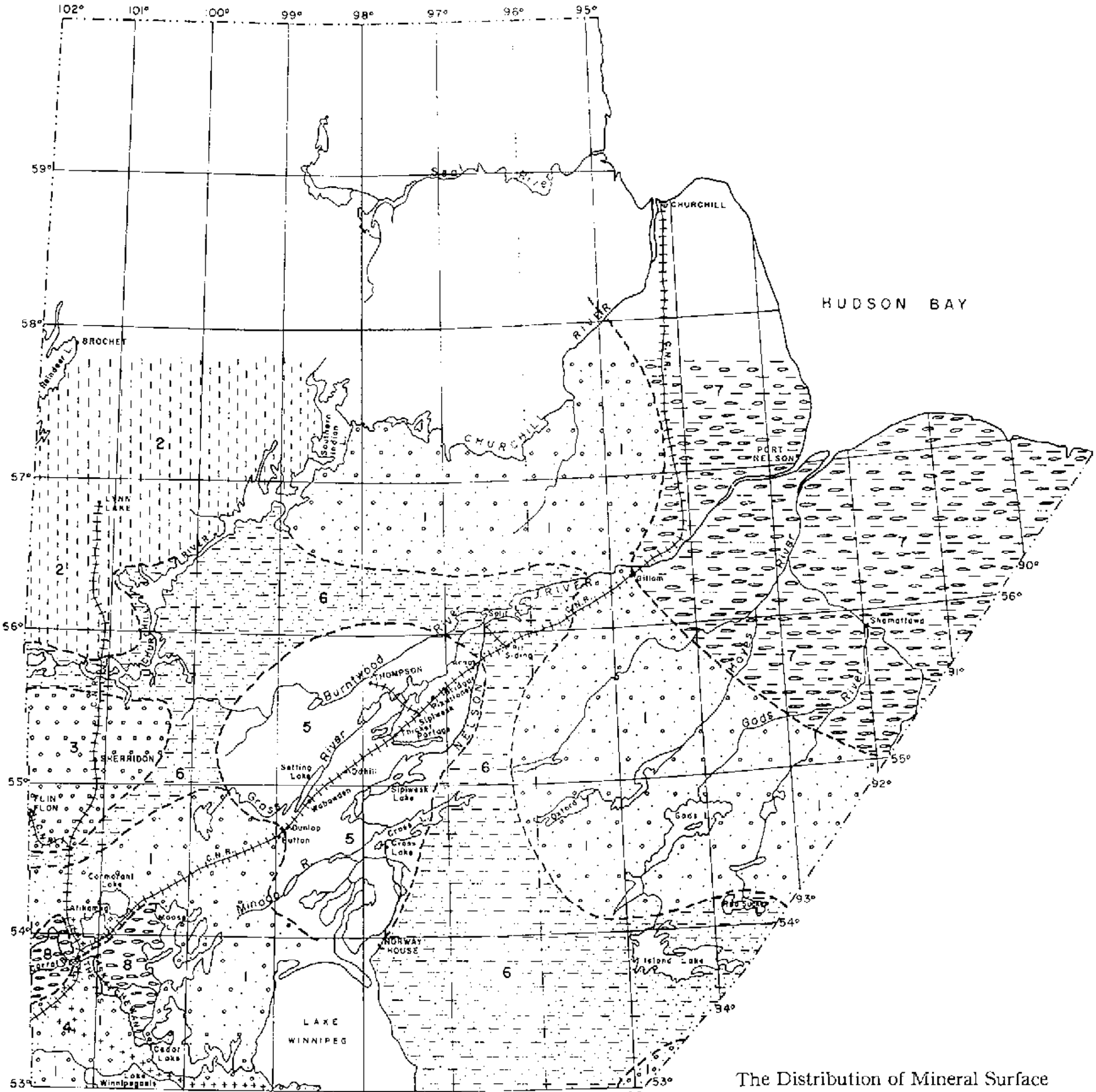
The margin of the localized clay areas corresponds with the approximate boundary of glacial Lake Agassiz at its latest stage before drainage into Hudson Bay was opened by the ice recession. This stage was at approximately 800 feet above sea level. The margin of the marine and alluvial deposits is at approximately 450 feet above present sea level and corresponds with the area covered by sea water in the immediate post glacial period.

Within the surveyed section, the mineral surface deposits are almost entirely fine textured lacustrine sediments. These sediments are covered by a variable depth of peat deposits throughout 52 percent of the section, and 17 percent is occupied by lakes and rock outcrops. A few beach-like ridges of sand and small deltas and bars of silt occur in the portion west and south of Wabowden. Silty deposits are more common in the southern portion of the clay belt especially at Hill Lake and in the Saskatchewan River delta. No deposits of glacial till were observed in the surveyed section, but it is expected that till does occur below the peat and clay deposits in the many deep depressions.



Rock Formations of Northern Manitoba

FIGURE 5



The Distribution of Mineral Surface Deposits in Northern Manitoba

LEGEND

GLACIAL TILL DEPOSITS
- a. CALCAREOUS TILL (looms to clay looms) 1
- b. NON-CALCAREOUS TILL (sands to looms) 2
- c. COMPLEX OF CALCAREOUS AND NON-CALCAREOUS TILL (Sands to clay looms) 3
- d. END MORAINE (sandy looms to clay looms) 4

LACUSTRINE DEPOSITS
- a. CLAYS AND LOCALIZED AREAS OF SILTS AND SANDS 5
- b. LOCALIZED CLAY AREAS 6

MARINE AND ALLUVIAL DEPOSITS
- CLAYS, SILTS AND SANDS 7

RECENT ALLUVIAL DEPOSITS
- CLAYS, SILTS AND SANDS 8

FIGURE 6

FIGURE 7

Thin deposit of lacustrine clay over granitoid bedrock.

FIGURE 8

Twenty-five feet of lacustrine clay exposed along the Burntwood River.

FIGURE 9

Ten feet of peat exposed in excavation at Mile 159 along the Hudson's Bay Railway.

FIGURE 10

Bank of coarse textured, non-calcareous glacial till near Lynn Lake.

F. RELIEF AND DRAINAGE

Northern Manitoba is a region of moderately low relief. The topography varies with the bedrock formations from the level terrain of the Hudson Bay and Manitoba Lowlands, underlain with flat-bedded limestone, to the undulating plain of the Pre-Cambrian Shield, where rock bosses and sharp rock cliffs give the surface an uneven configuration. The drainage pattern of the region is very youthful or immature. The recent glaciation and the hardness of the exposed rocks have left the area with few well-formed rivers. The principal river systems that drain the area (the Hayes, Nelson, Churchill and Seal rivers) consist of series of lakes joined by short river channels. Within the Pre-Cambrian Shield the rivers and lakes are bounded by sharp rock cliffs and have many shoals and rapids.

The glacial Lake Agassiz basin, with its axial belt of clay deposits, is separated from the Hudson Bay Lowland by a broad height of land composed of Pre-Cambrian rocks. The clay belt itself lies in a basinal area below the 800-foot contour. While complete contour maps are not available for this clay area, the elevations of the stations along the Hudson's Bay Railway give some information on relief in the surveyed section. Button, at the western edge, is 770 feet above sea level. To the south-west, the land rises 91 feet in eight miles. To the north-east, the land-fall is slight to Wabowden (765 feet a.s.l.) but a sharper descent of 141 feet is shown in the next 76 miles to Pikwitonei (624 feet a.s.l.). From Pikwitonei north-eastward to the Siding of Stitt, about two miles north and east of the Nelson River crossing, the land rises by 54 feet in 30 miles. These elevations indicate that the main clay area occupies a basin bounded on the west by a rise of land from approximately the 800 foot contour, and on the east by another rise from about the level of the 700 foot contour.

Within the clay belt the topography varies from level to moderately undulating. The level areas are occupied by bogs and the greatest local relief occurs around the margins of lakes and rivers where surface deposits are usually thin or absent. Surface drainage is variable. Approximately 65 percent of the surveyed section consists of lakes and peat-covered depressions. In the undulating areas, surface runoff is moderate to slow. The soils are moderately permeable and have a thick surface mat of leaf litter and mosses which greatly reduces runoff. Where this surface organic layer has been removed by fire the runoff is appreciably greater.

The runoff waters from the clay belt all empty into Hudson Bay by way of the Nelson River system. The principal tributary waterways within the clay area are the Minago, the Grass and the Burntwood rivers with their many confluent lakes.

G. CLIMATE

In relation to world-wide climatic conditions, northern Manitoba is within the region designated by Köppen as Dfc.* This is a subarctic climate of the humid microthermal type with a short, warm summer and a cold, snowy winter. The clay area of the Upper Nelson River Basin lies in the southern portion of this climatic belt and the temperatures here approach those of the humid continental climate.

The climatic data available for Wabowden are given in Tables 1, 2 and 3. For comparative purposes, the monthly precipitation and temperature records for Le Pas and Norway House are presented in Tables 4 and 5. The data for Wabowden may be taken as being representative of the central portion of the clay belt, and that for Norway House as representing conditions in the southern portion. Slightly lower mean monthly temperatures may be expected in the northern and north-eastern parts. Also, some local variations will occur due to the moderating influence of the larger bodies of water, particularly in the spring and fall seasons.

*W. Köppen and Geiger, "Handbuch der Klimatologie", Bond I, Teil C, Gebuder Borntraeger, Berlin, 1936.

The shortness of the growing season and the danger of late spring and early summer frosts appear to be the principal limiting climatic factors to agricultural development in this northern area. The average length of the frost-free period at Wabowden, during the 10 years of records, has been 90 days and has varied from 68 days in 1945 to 109 days in 1953. This length of frost-free period is marginal for the growth to maturity of present varieties of grain crops. However, one favouring aspect that will affect the growth of crops in this northern region is the length of daylight during the summer months. At the summer solstice, the length of time per day of possible sunlight is 17 hours 25 minutes at 58° latitude, as compared with 16 hours 22 minutes at 50° latitude.* From Weyer's chart it was estimated that Wabowden has 61 hours more possible sunlight than Winnipeg during the months of June, July and August.

FIGURE 12

Black spruce and tamarack forest cover on Half Bog soils.

H. VEGETATION

Northern Manitoba lies almost entirely in the Boreal Forest Region as delineated by

FIGURE 11

Deciduous and coniferous forest cover in the Drunken Lake area.

FIGURE 13

Spruce forest at Sipiwesk, Mile 200 of the Hudson Bay Railway.

*Weyer, Edward. "How Much Sunlight Will There Be?", The Beaver, p. 35, March 1949.

Halliday.** Only a narrow fringe along the coast of Hudson Bay has been included with the Tundra Formation. The clay belt, along with the area of localized clay deposits, has been separated as the Nelson River Section of the Boreal Forest Region.

The native vegetation in this section consists largely of black spruce associations. But, owing to the extensive and numerous swamps, the trees are mostly of restricted growth. Adjacent to the rivers and on well-drained areas the vegetation consists of mixed stands of white spruce, white birch, jack pine, balsam fir, aspen, black poplar and black alder. Extensive and repeated fires have altered the forest cover and greatly reduced its merchantible timber. Large areas now support fairly pure stands of aspen and of jack pine where few had previously existed. The trees are generally young and seldom exceed 30 feet in height. Tamarack and black spruce are the dominant species in the bog areas.

**Halliday, W. E. D. "A Forest Classification for Canada". Canada Department of Mines and Resources, Forest Service, Bull. 38, 1937.

TABLE 1

Mean Monthly Precipitation at Wabowden, Manitoba from 1945 to 1957

Months	Number of Years Recording	Mean Monthly Precipitation in Inches	Monthly Precipitation Range in Different Years	
			Highest Monthly Mean	Lowest Monthly Mean
January	11	0.70	1.83 (1947)	0.20 (1957)
February	12	0.57	1.31 (1950)	0.17 (1951)
March	12	0.52	1.53 (1953)	0.17 (1952)
April	13	0.86	2.32 (1949)	0.06 (1952)
May	13	1.65	3.28 (1950)	0.04 (1948)
June	13	2.79	4.76 (1951)	0.68 (1948)
July	12	2.75	4.55 (1949)	1.10 (1956)
August	11	2.46	4.99 (1950)	1.11 (1952)
September	12	2.40	4.19 (1951)	1.10 (1956)
October	12	1.16	1.87 (1950)	0.54 (1945)
November	12	1.06	1.90 (1955)	0.32 (1946)
December	12	0.71	1.25 (1946)	0.30 (1951)
		Yearly Mean 17.63	Highest 12 Months November to October 22.58 (1949-50)	Lowest 12 Months November to October 12.50 (1955-56)

TABLE 2
Mean Monthly Temperatures at Wabowden, Manitoba
from 1945 to 1957

Month	Number of Years Recording	Mean Monthly Temperatures in Degrees Fahrenheit	Range of Temperatures	
			Highest Monthly Mean in Degrees Fahrenheit	Lowest Monthly Mean in Degrees Fahrenheit
January	11	-12.4	-5.2 (1948)	-27.0 (1950)
February	12	-4.5	8.8 (1954)	-12.7 (1949)
March	13	9.8	20.9 (1946)	3.0 (1948)
April	13	27.6	39.8 (1952)	19.0 (1945)
May	13	42.8	48.0 (1952)	36.8 (1945)
June	13	54.6	60.0 (1955 and 1956)	50.2 (1950)
July	12	62.4	65.6 (1947)	58.3 (1949)
August	11	59.0	63.0 (1953)	54.2 (1950)
September	12	48.8	60.3 (1952)	43.0 (1956)
October	12	36.3	43.5 (1947)	31.4 (1951)
November	12	15.3	25.1 (1953)	9.4 (1951)
December	12	-3.8	9.0 (1954)	-11.0 (1955)
		Mean Annual Temperature 27.9°F	Highest Annual Mean 29.8°F (1953)	Lowest Annual Mean 24.3°F (1950)

TABLE 3
Some Climatic Factors at Wabowden, Manitoba
1945 to 1954 inclusive

Mean date of last frost in spring (<33°F)	June 7
Range of last frosts in spring (<33°F)	May 28 (1948) to June 25 (1945)
Mean date of first frost in fall	September 6
Range of first frosts in fall	August 25 (1950) to September 24 (1953)
Average duration of frost free period	90 days
Shortest frost free period	68 days (1945)
Longest frost free period	109 days (1953)
Mean date of beginning of vegetative period*	May 28
Range of beginning of vegetative periods	May 11 (1948) to June 6 (1945)
Mean date of end of vegetative period	September 23
Range of end of vegetative periods	September 14 (1945 and 1947) to October 3 (1953)
Average duration of vegetative period	118 days
Shortest vegetative period	99 days (1945)
Longest vegetative period	141 days (1948)

*Vegetative period is considered as the period during which the mean daily temperature is at or above 42°F.

TABLE 4

Mean Monthly Precipitation at Le Pas and Norway House

Station and Location	Years Observed	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Le Pas Lat. N53° 49′, Long. W101° 15′, El. 890′ a.s.l.	45	0.76	0.63	0.76	0.94	1.54	2.36	2.56	2.33	1.95	1.15	1.11	0.83	16.92
Norway House Lat. N53° 58′, Long. W97° 51′, El. 720′ a.s.l.	40	0.69	0.78	1.01	0.74	1.08	1.93	2.29	2.38	1.85	0.93	1.07	0.83	15.58

TABLE 5

Mean Monthly Temperature at Le Pos and Norway House

Station	Years Observed	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Le Pas	45	-6.9	-1.0	12.0	35.9	48.1	58.3	64.6	61.2	50.4	37.6	17.7	1.3	31.6
Norway House	40	-11.0	-4.0	9.0	29.0	45.0	57.0	63.0	60.0	48.0	36.0	16.0	-2.0	29.0

PART II

SOILS

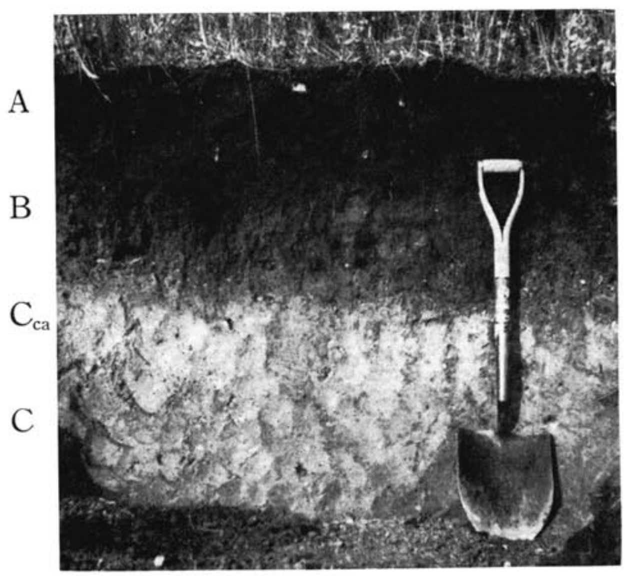
The soils that have developed under the influence of the soil-forming factors of parent material, relief, drainage, climate and vegetation, referred to in Part I, exhibit physical characteristics which reflect their environment. Through observation of these characteristics, it is possible to classify soils in accordance with their genesis or the processes involved in their formation. Such a classification scheme permits the grouping of soils into natural units. The recognition of these units is dependent on the study of the soil profile.

A. SOIL PROFILE

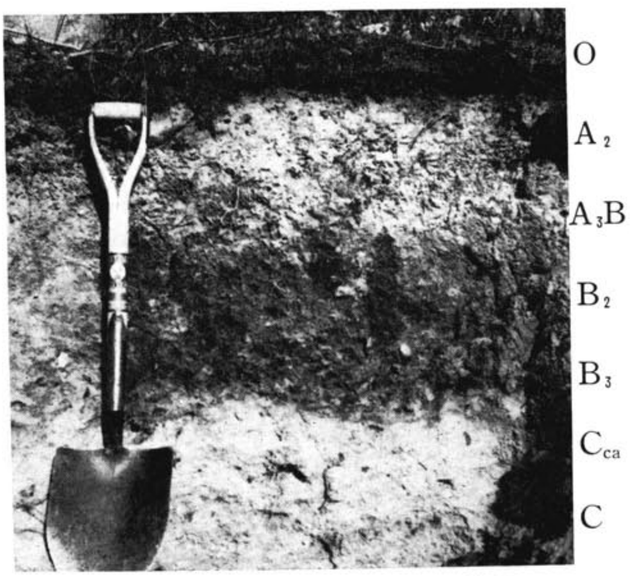
The soil profile, as viewed in vertical cross-section, consists of the various soil layers to a depth of three or more feet. These layers are called soil horizons and differ from one another in one or more of the following features: color, texture, structure, consistence, reaction, thickness, concretions, intrusions, and chemical and biological composition. The master horizons are designated by the letter symbols O, A, B, C and D. For more detailed description these master horizons may be subdivided into sub-horizons, in which case they are designated as A_1, A_2, A_3, B_1, B_2, etc. The master horizons are described in Table 6. Examples of the use of this horizon nomenclature are given in Figure 14.

FIGURE 14

Examples of the use of soil horizon nomenclature.



Black soil profile showing subdivision into soil horizons.



Grey Wooded soil profile showing subdivision into soil horizons.

TABLE 6
Definitions of Soil Horizons

O HORIZON—Organic accumulation on the surface of the soil composed of leaf litter, muck or peat deposits.

A HORIZON—The horizon of maximum weathering and of maximum removal of the products of weathering by downward movement of water. In grassland soils it is also the horizon of maximum accumulation of organic matter.

A_1 Sub-horizon—Surface mineral layer with maximum accumulation of organic matter; dark in color.

A_2 Sub-horizon—Layer of maximum leaching; light in color; prominent in most forest soils; absent in most grassland soils.

A_3 Sub-horizon—Transition layer to the B but more like the A than B.

B HORIZON—The horizon of less intense weathering. This horizon is characterized by: a concentration of clay, iron, aluminum or organic matter; usually a blocky or prismatic structure; a color unlike that of the A or C horizons; or a combination of these features.

B_1 Sub-horizon—Transition layer to the A above, but more like the B than A.

B_2 Sub-horizon—Layer of maximum development of the features that characterize the B horizon.

B_3 Sub-horizon—Transition layer to the C, but more like the B than C. Sometimes absent.

C HORIZON—The horizon of relatively unweathered material, that is similar in composition to the material from which at least a portion of the overlying solum has developed. Slight alterations in the nature of this material due to the accumulation of carbonates or soluble salts, or to the process of gleyzation are designated by the use of subscripts.

D HORIZON—Any stratum underlying the C or the B if no C is present, which is unlike the material from which the solum (A and B horizons) has formed.

LETTER SUBSCRIPTS

ca—Used to denote visible concentration of carbonates (dominantly calcium carbonate) which most commonly occurs in the C horizon immediately below the B.

cs—Used to denote a visible concentration of gypsum (calcium sulphate) which may occur in any horizon but most commonly in the C.

g—Used to denote the process of gleyzation as indicated by greyish colors and red and brownish mottling. This condition is caused by oxidation and reduction processes associated with a fluctuating water table and may occur in any horizon.

B. SOIL CLASSIFICATION

The soils in the surveyed section of the clay area along the Hudson Bay Railway were classified into twelve soil series. In this survey, the soil series was the lowest unit of classification used. In the field, the soils were mapped as complexes because most of the areas of individual series were too small to be mapped separately. In the report and on the soil map, the estimated acreages are presented of the complexes and of the soil series within the complexes.

C. SOIL MAPPING

The surveyed area was covered by foot traverses radiating one to three miles from each side of the railway. In the more accessible areas the traverses were one mile apart, but were less frequent in large areas of bog soils. Soils were examined along the railway and on the traverses at intervals depending on the apparent variability. All information was plotted on aerial photographs having a scale of slightly less than four inches per mile. Through aerial photograph interpretation the soil boundaries were extended from one to five miles beyond the traversed area. A soils map on the scale of 1:100,000 was prepared from the information obtained.

FIGURE 15
Soil Survey Staff in Northern Clay Region, 1957.

D. CLASSIFICATION AND DESCRIPTION OF SOILS

A key to the soil series occurring in the surveyed area is given in Table 7; and a key to the soil complexes used as mapping units is presented in Table 8. In the soil descriptions that follow, detailed information is presented on the profile features that characterize each of the soil series, and some generalizations are made with regard to the mapping units.

TABLE 7
Soils of the Clay Area in the Upper Nelson River Basin

Soil	Soil Sub-Group	Natural Drainage	Surface Deposits	Estimated Acreage
Wabowden series	Solonetzic Grey Wooded	Moderately well drained.	Lacustrine clay.	175,475
Sipiwesk series	Orthic Grey Wooded	Moderately well drained.	Lacustrine clay.	450
La Perouse series	Peaty Grey Wooded Gley	Poorly drained.	6 to 12 inches of peat on lacustrine clay.	——
Medard series	Peaty Gleysol	Poorly drained.	6 to 12 inches of peat on lacustrine clay.	730
Pipun series	Orthic Grey Wooded	Moderately well drained.	Thin lacustrine clay on lacustrine silt.	1,035
Minago series	Orthic Grey Wooded	Moderately well drained.	Lacustrine silt.	70
Dunlop series	Peaty Gleysol	Poorly drained.	6 to 12 inches of peat on lacustrine silt.	120
Clarke series	Podzol	Well-drained.	Lacustrine sand.	3,500
Pakwa series	Gleyed Podzol	Imperfectly drained.	Lacustrine sand.	——
Half Bog	——	Very poorly drained.	12-30 inches of peat generally underlain with clay.	65,825
Bog	——	Very poorly drained.	More than 30 inches of peat.	214,570
Rockland	——	——	Deposits over bedrock are thin to absent.	15,885

TABLE 8

Soil Complexes

Soil Complex Map Symbol	Soils	Land Pattern	Acreage of Soil Complex
1	Wabowden..................80-100% Half Bog and others.......... 0- 20%	Irregular, gently to moderately sloping with some peaty depressions.	123,550
2	Wabowden..................60- 80% Half Bog and others..........20- 40%	Irregular, gently to moderately sloping with about 30 percent covered with peat.	46,990
3	Wabowden..................40- 60% Half Bog and others..........40- 60%	Irregular, very gently to gently sloping with about 50 percent covered with peat.	42,080
4	Wabowden..................20- 40% Half Bog and others..........60- 80%	Irregular, level to gently sloping with about 70 percent covered with peat.	8,280
5	Wabowden..................60- 80% Rockland and others..........20- 40%	Irregular, gently to moderately sloping with small areas of Rockland.	7,710
6	Wabowden..................40- 60% Rockland and others..........40- 60%	Irregular, gently to steeply sloping with about 50 percent of Rockland.	3,880
7	Wabowden..................20- 40% Rockland and others..........60- 80%	Irregular, moderately to steeply sloping with about 70 percent of Rockland.	—
8	Sipiwesk....................80-100% Wabowden and others.......... 0- 20%	Irregular, gently to moderately sloping with a few small peaty areas.	500
9	Medard....................80-100% Others..................... 0- 20%	Level to very gently sloping.	730
10	Pipun.......................80-100% Wabowden and others.......... 0- 20%	Irregular, very gently to gently sloping with some peaty areas.	1,150
11	Minago....................40- 60% Wabowden and others..........40- 60%	Irregular, very gently sloping with some peaty areas.	140
12	Dunlop....................80-100% Others..................... 0- 20%	Level to very gently sloping with some peaty areas.	120
13	Clarke....................80-100% Others..................... 0- 20%	Irregular, very gently to gently sloping with some peaty areas.	3,500
14	Half Bog..................80-100% Others..................... 0- 20%	Level to very gently sloping with a few low knolls.	12,540
15	Bog.......................80-100% Others..................... 0- 20%	Generally level with a few low knolls.	214,570
16	Rockland..................80-100% Others..................... 0- 20%	Mainly low hills of granitoid rock outcrop.	10,950
	Lakes........................		81,840
Total Area..			559,500

SOILS DEVELOPED ON LACUSTRINE CLAY

The largest portion of the arable acreage in the surveyed section consists of moderately calcareous clay. The soils developed on these sediments are: Solonetzic Grey Wooded, Orthic Grey Wooded, Peaty Grey Wooded Gley and Peaty Gleysol. These soil sub-groups are respectively represented by the following series: Wabowden, Sipiwesk, La Perouse and Medard.

WABOWDEN SERIES (175,475 acres)

The Wabowden series is a moderately well drained, Solonetzic Grey Wooded, clay soil with a strongly developed, granular to sub-angular blocky A_2 horizon and a strongly developed, columnar or prismatic structured B_2 horizon. The parent material of this soil is varved clay with a moderate content of lime carbonate.

The Wabowden series occupies about 31 percent of the surveyed section and is the most extensive of the better drained soils. This soil is distributed over the entire area in variable sized parcels of land ranging from two to fifty or more acres. Wet areas, in general, separate the better-drained soils. The terrain on which these soils occur is irregular gently to moderately sloping. This undulating topography is due to the conformity of the lacustral sediments to the configuration of the underlying rocks. The elevated portions of the landscape indicate the proximity of bedrock to the surface; in numerous places the bedrock is exposed or is covered with a very thin mantle of clay. Thick deposits of clay are present in the nearly level areas and in the depressions. Deposits with a thickness of fifty or more feet have been noted at several points within the clay region.

The vegetation varies from site to site. Originally spruce was the dominant tree but, because of fires, it has been replaced in many sites by jack pine, aspen and birch. At present young spruce is abundant in the burned over areas and eventually will again dominate the forest cover if the area remains free of fires.

Internal drainage of the Wabowden soil is moderately good even through the compact B horizon. The favourable permeability is due principally to the prolification of tree roots. Under cultivated conditions, the internal drainage is expected to decrease considerably.

A description of a representative Wabowden soil profile is given below:

O —Very dark brown (dry and moist) leaf mat (2 to 5 inches thick); partly decomposed; medium acid.

A_2—Light grey (dry) to light brownish grey (moist) clay loam (2 to 4 inches thick); fine granular to fine sub-angular blocky; sticky and plastic when wet, hard when dry; medium acid.

A_3—Dark greyish brown (dry) to dark grey (moist) clay (2 to 6 inches thick); strongly developed, coarse sub-angular blocky; hard when dry, sticky and plastic when wet; medium acid.

B_2—Dark yellowish brown (dry) to very dark greyish brown (moist) clay (8 to 12 inches thick); strongly developed, coarse columnar structure; very hard when dry, sticky and very plastic when wet; medium acid.

B_3—Brown (dry) to dark greyish brown (moist) clay (3 to 6 inches thick); medium developed, fine sub-angular blocky; hard when dry, sticky and plastic when wet; mildly alkaline.

C_1—Very pale brown (dry) to brown (moist) clay (4 to 9 inches thick); pseudo-crumb structure; hard when dry, sticky and plastic when wet; mildly alkaline; contains carbonates and iron concretions.

C_2—Brown (dry) to dark greyish brown (moist) clay with thin bands of silt; pseudo-crumb structure; hard when dry; sticky and plastic when wet; mildly alkaline; contains carbonates and iron concretions.

FIGURE 16
Soil profile of Wabowden clay. A Solonetzic Grey Wooded soil developed on lacustrine clay.

Mapping Complexes:

The Wabowden series forms a part of ten mapping complexes (see Table 8). Principal among these are the complexes in which variable percentages of Wabowden soils occur in association with Half Bog and Rockland. The other complexes, in which small percentages of Wabowden soils are associated with Sipiwesk, Medard or Pipun soils, are very minor in extent.

The topography and pattern of soil distribution within these complexes are variable. Generally the relief is greatest in areas with a high percentage of better drained soils and rockland. The most rugged topography occurs in areas that are dominantly rockland, especially in the areas north-east of Wabowden and north-east of Thicket Portage.

Analysis and Fertility:

The analytical data on the Wabowden clay, presented in Table 9, show that the soil is low in natural fertility. The surface mineral horizons are low in organic matter, nitrogen and phosphorus, and are strongly acid in reaction. Sulphur content also is low, but crop response to sulphur application may occur only with legume crops. Liming the soil may assist in promoting growth of young legume plants, and possibly others, but this can be verified only through experimentation. Exchangeable calcium, magnesium and potassium are present in sufficient quantities for plant requirements. Salinity in the parent material is insignificant. Clay content is high, consequently poor tilth is expected in cultivated soils where organic matter content is inadequate. Poor tilth will be a problem in new breaking where the surface organic matter has been destroyed by fires or removed by the bulldozer in the clearing process.

TABLE 9

Analysis of Wabowden Clay

Horizon	O	A_2	A_3	B_2	B_3	C_1	C_2	C_2
Depth (inches)	2–0	0-2.5	2.5–5	5–16	16–21	21–25	25–35	35+
Moisture Equivalent	102.6	46.7	38.3	39.8	37.3	34.7	35.6	37.7
Sand (%)	...	3.8	...	.3	...	...	.7	.7
Silt (%)	...	36.7	...	21.7	...	...	22.9	23.0
Clay (%)	...	59.5	...	78.0	...	...	76.4	76.3
Organic Carbon (%)	35.09	2.97	1.57	1.01	.55	.30	.30	.22
Total Nitrogen (%)	1.25	.20	.13	.10	.08	.06	.05	.04
C/N Ratio	28.1	14.8	12.5	10.1	...	...	...	...
Total P (%)	.13	.05	.03	.03	.05	.05	.05	.05
Available P (P.P.M.)	56	18	6	6	4	...	...	...
Total SO_3	.24	.05	.02	.02	.02	.03	.03	.04
Inorganic CO_3 (%)	...	...	...	...	3.67	8.44	10.79	10.51
pH Values	4.8	4.8	5.0	6.1	7.3	7.6	7.8	7.9
Exch. Cap. (m.e.)	...	36.2	30.0	35.6	32.3	...	...	...
Exch. Ca. (m.e.)	...	14.2	14.4	16.5	18.0	...	...	...
Exch. Mg. (m.e.)	...	6.3	7.5	14.1	13.3	...	...	...
Exch. Na. (m.e.)	...	.2	.2	.3	.2	...	...	...
Exch. K. (m.e.)	...	.8	.8	1.0	.8	...	...	...
Exch. H. (m.e.)	31.3	14.7	7.1	3.7	...	...	...	...
Conductivity (mmhos)	...	...	...	.2	.6	.9	...	.5

SIPIWESK SERIES (450 acres)

The Sipiwesk series is a moderately well drained, Orthic Grey Wooded, clay soil with a granular to shotty-like structured A_2 horizon and a strongly developed sub-angular blocky to blocky B horizon. These soils have developed on clay parent material with a moderate content of lime carbonate.

The area covered by the Sipiwesk soil is small. These soils occupy the high sites of the undulations and where the bedrock is near to the surface. The Sipiwesk soils, in general, occur in small isolated areas that are surrounded by the Wabowden series. The largest areas of these soils are located in the vicinities of Thicket Portage, Leven and Bridgar.

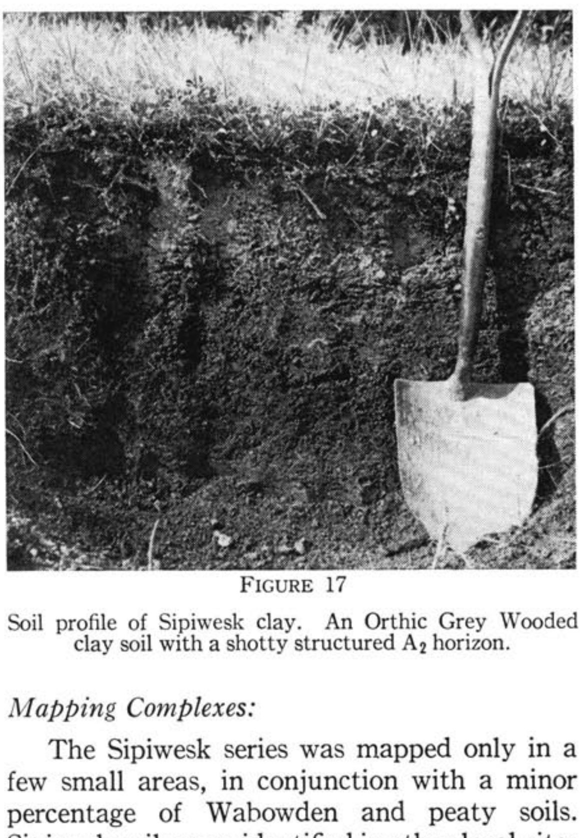


FIGURE 17

Soil profile of Sipiwesk clay. An Orthic Grey Wooded clay soil with a shotty structured A_2 horizon.

The vegetation originally consisted of spruce but this tree species has been replaced in part by jack pine, aspen and birch. Both jack pine and aspen in places occur in relatively pure stands.

Internal soil drainage is excellent for a clay textured soil due mainly to well developed shotty-like and sub-angular blocky structures. In the soils with a weakly developed prismatic structure the drainage is less favourable.

A description of a representative Sipiwesk soil profile is given below:

O —Very dark brown (dry and moist) leaf mat (2 to 4 inches thick); weakly decomposed; medium acid.

A_2—Light grey (dry) to brown (moist) clay (2 to 4 inches thick); strongly developed medium shotty to medium granular structure; slightly sticky and plastic when wet, hard when dry; medium acid.

A_3—Very pale brown (dry) to dark brown (moist) clay (2 to 4 inches thick); strongly developed, fine sub-angular blocky structure; very firm when moist, very hard when dry; medium acid.

B_1—Brown (dry) to dark brown (moist) clay (2 to 5 inches thick); strongly developed, fine blocky structure very firm when moist, very hard when dry; medium acid.

B_2—Greyish brown (dry) to dark brown (moist) clay (5 to 8 inches thick); strongly developed, fine to medium blocky; some profiles have weak prismatic structure; very firm when moist, extremely hard when dry; medium acid.

B_3—Pale brown (dry) to dark brown (moist) clay (3 to 8 inches thick); medium developed, medium granular; friable when moist, hard when dry; mildly alkaline.

C_1—Light brownish grey (dry) to dark greyish brown (moist) clay (6 to 10 inches thick); fine pseudo-fragmental; friable when moist, hard when dry; calcareous.

C_2—Pale brown (dry) to greyish brown (moist) varved clay; fine pseudo-fragmental; friable when moist, hard when dry; calcareous and iron stained.

Mapping Complexes:

The Sipiwesk series was mapped only in a few small areas, in conjunction with a minor percentage of Wabowden and peaty soils. Sipiwesk soils were identified in other local sites within Wabowden soil areas, usually on the highest positions where bedrock is close to the surface. However, in these sites the areas of Sipiwesk soils were too small to be mapped separately and were included with the Wabowden complexes.

Analysis and Fertility:

The analytical data for the Sipiwesk soils are presented in Table 10. These analyses indicate that the Sipiwesk soils, like the Wabowden soils, are low in natural fertility. However, the Sipiwesk soils have a more favourable structure than the Wabowden soils and should not present the same problem of poor tilth.

TABLE 10

Analysis of Sipiwesk Clay

Horizon	A_2	A_3	B_1	B_2	B_3	C_1	C_2
Depth (inches)	0–2	2–4	4–7	7–12	12–20	20–27	27+
Moisture Equivalent	44.6	41.9	42.5	43.6	39.1	38.4	38.3
Sand (%)	3.5	...	...	.5	...	...	.4
Silt (%)	24.5	..	...	14.5	...	...	19.5
Clay (%)	72.0	...	...	85.0	...	...	80.1
Organic Carbon (%)	2.31	1.13	.64	.71	.32	.25	...
Total Nitrogen (%)	.14	.11	.06	.04	.05	.05	.07
C/N Ratio	16.2	10.8	10.6	...	...	...	...
Total P (%)	.03	.03	.03	.03	.04	.02	.01
Available P (P.P.M.)	4	4	4	4	...	...	...
Total SO_3 (%)	.03	.02	.02	.02	.02	.01	.01
Inorganic CO_3 (%)	...	...	...	...	8.92	11.29	13.27
pH Values	5.9	5.8	5.8	6.2	7.7	7.7	7.8
Exch. Cap. (m.e.)	24.4	29.5	37.7	39.5	28.7	...	...
Exch. Ca. (m.e.)	16.6	19.1	25.0	26.3	21.2	...	...
Exch. Mg. (m.e.)	2.8	5.2	8.0	8.9	6.6	...	...
Exch. Na. (m.e.)	.1	.1	.2	.3	.2	...	...
Exch. K. (m.e.)	.4	.6	.9	1.0	.7	...	...
Exch. H. (m.e.)	4.5	4.5	3.6	3.0	...	...	...
Conductivity (mmhos)	...	...	...	...	.4	...	.4

LA PEROUSE SERIES

The La Perouse series is a weakly developed, Peaty Grey Wooded Gley soil with moderately developed, shotty-like structure in the A_2 horizon and granular to sub-angular blocky structure in the B horizon. In this soil, the A_2 is thin and the clay concentration in the B horizon is slight.

These soils occupy small portions of the nearly level areas that surround some of the Half Bog and Bog areas. The vegetation is mainly black spruce and tamarack with some willow and black alder. The ground cover is dominated by mosses of various kinds.

Internal drainage is poor due to a high water table, but the permeability in the solum is excellent due to the large pore space resulting from the shot-like aggregates. In the C horizon, the permeability is restricted by the close packing of the fine textured material.

A description of the representative La Perouse soil profile is given below:

O —Dark reddish brown (dry and moist) peat layer (6-12 inches thick); weakly decomposed; slightly acid.

A_1—Dark grey (dry) to black (moist) clay, high in organic matter (1 to 2 inches thick); weakly developed, fine granular structure; plastic and sticky when wet, slightly hard when dry; slightly acid to neutral.

A_2—Dark greyish brown (dry) to very dark greyish brown (moist) clay (1 to 2 inches thick); strongly developed, fine shot-like structure; plastic and sticky when wet; very hard when dry; neutral; gleyed and iron stained.

B_2—Very dark brown (dry) to black (moist) clay (2 to 4 inches thick); strongly developed, medium shot-like structure; plastic and sticky when moist, very hard when dry; neutral; gleyed and iron stained.

B_3 -Greyish brown (dry) to very dark greyish brown (moist) clay (2 to 4 inches thick); strongly developed, coarse shot-like structure; sticky and very plastic when wet, very hard when dry; mildly alkaline; gleyed, iron stained and contains some free lime carbonate.

C_1—Light brownish grey (dry) to dark greyish brown (moist) clay (6 to 10 inches thick); fine pseudo-granular; sticky and very plastic when wet, hard when dry; mildly alkaline; calcareous and iron stained. Usually contains thin bands of silt.

C_2—Similar to C_1 except that this horizon is slightly higher in carbonates.

Mapping Complexes:

La Perouse soils were identified only in very small, local sites bordering the more poorly drained areas. Where these occurred they were included with the surrounding soil complex.

Analysis and Fertility:

In the principal morphological features, the La Perouse soil is the poorly drained equivalent of the Sipiwesk series. Base saturation and pH are higher than in the better drained soils (see Table 11). Organic matter supply initially should not be a problem in land to be cultivated providing the peaty layer is incorporated with the mineral soil. Nitrogen and phosphate are low and should be applied to crops that can be grown.

TABLE 11

Analysis of La Perouse Clay

Horizon	O	A_1	A_2	B_2	B_3	C_1	C_2
Depth (inches)	5–0	0–2	2–3	3–7	7–9	9–16	16+
Moisture Equivalent	130.0	69.9	31.0	34.5	32.4	31.1	33.0
Sand (%)	...	8.4	...	3.1	...	...	1.0
Silt (%)	...	45.1	...	39.1	...	...	28.4
Clay (%)	...	46.5	...	57.8	...	...	70.6
Organic Carbon (%)	39.49	13.14	3.01	1.47	.45	.54	.23
Total Nitrogen (%)	...	.69	.24	.12	.05	.03	.04
C/N Ratio	...	19.1	12.1	12.2	...	...	...
Total P (%)	.08	.05	.04	.04	.05	.03	.04
Available P (P.P.M.)	28	20	14	8	2	...	...
Total SO_3 (%)	.29	.16	.01	.02	.02	.01	.01
Inorganic CO_3 (%)	...	.42	...	.26	6.91	12.70	10.84
pH Values	5.9	7.0	6.8	7.1	7.6	7.8	7.9
Exch. Cap. (m.e.)	...	76.3	...	40.4	39.7	...	...
Exch. Ca. (m.e.)	...	57.2	...	31.5	33.1	...	...
Exch. Mg. (m.e.)	...	15.2	...	8.0	5.8	...	...
Exch. Na. (m.e.)	...	.3	...	.3	.2	...	...
Exch. K. (m.e.)	...	.4	...	.6	.6	...	...
Exch. H. (m.e.)	20.5	3.2	...	...	...	...	...
Conductivity (mmhos)	...	...	...	...	.3	.3	.3

MEDARD SERIES (730 acres)

The Medard series is a Peaty Gleysol soil with little or no A horizon. In some soils a thin A_1 horizon, less than two inches thick, is present. Strong gleying immediately below the organic layer is the prominent feature of the profile.

This soil occupies the slight depressions and some of the nearly level areas bordering the Half Bog and Bog soils. Its vegetative cover consists mainly of black spruce and tamarack. Permeability of the Medard soil is low because of the fine textured materials and the high ground water level that persists for the greater part of the year.

A description of the representative Medard soil profile is given below:

O —Very dark brown (dry and moist) peat layer (6 to 12 inches thick); weakly decomposed; strongly acid.

A_1—Very dark grey (moist) clay, high in organic matter (<2 inches thick); granular structure; moderately sticky and very plastic; medium acid to neutral. Horizon may be absent.

Cg—Greyish brown (moist) clay (4 to 16 inches thick); weakly developed, medium pseudo-granular; very sticky and very plastic; medium acid to neutral; weakly calcareous; strongly gleyed; slightly iron stained.

C_2—Dark greyish brown (moist) varved clay; weakly developed, fine pseudo-fragmental; very sticky and very plastic; moderately alkaline; strongly iron stained; weakly gleyed; moderately calcareous.

Mapping Complexes:

A few small areas of Medard soils were separated as "Medard and others" complex. The Medard soils constitute 80 to 100 percent of these areas and the remainder may be Wabowden, La Perouse or Half Bog soils. Smaller areas of Medard soils were included with the other mapping complexes.

Analysis and Fertility:

The Medard soil, like the other clay soils, is low in nitrogen, phosphate and sulphur in the mineral portion of the profile (see Table 12). Where the soil can be cultivated, the peaty layer incorporated with the mineral sediments will supply adequate organic matter for a few years. Forage crops can be produced on this soil if sufficient drainage is provided.

TABLE 12
Analysis of Medard Clay

Horizon	O	$C_{11}g$	$C_{12}g$	C_2
Depth (inches)	8–0	0–4	4–16	16+
Moisture Equivalent	133.6	43.1	38.9	37.7
Sand (%)	....	6.8	1.7	.8
Silt (%)	....	31.3	28.4	22.2
Clay (%)	....	61.9	69.9	77.0
Organic Carbon (%)	38.4	20.8	.57	....
Total Nitrogen (%)	1.56	.15	.06	.02
C/N Ratio	....	14.1	9.3	....
Total P (%)	.10	.03	.05	.04
Available P (P.P.M.)	24	6	2	....
Total SO_3 (%)	.30	.01	.02	.02
Inorganic CO_3 (%)	....	....	....	8.60
pH Values	4.5	5.1	5.5	7.6
Exch. Cap. (m.e.)	....	30.5	30.7	....
Exch. Ca. (m.e.)	....	13.1	17.2	....
Exch. Mg. (m.e.)	....	6.3	8.1	....
Exch. Na. (m.e.)	....	.3	.3	....
Exch. K. (m.e.)	....	.5	.6	....
Exch. H. (m.e.)	39.0	10.3	4.5	....
Conductivity (mmhos)	....	....	....	.2

SOILS DEVELOPED ON LACUSTRINE CLAY UNDERLAIN WITH LACUSTRINE SILT

Soils developed on these sediments cover approximately 0.2 percent of the surveyed section and they occur mainly in the area extending west and south from Wabowden. The clay mantle over the silt is variable, ranging from 6 to 30 inches in total thickness.

The soils occurring on this two-storey parent material consist of: Orthic Grey Wooded, Gleyed Grey Wooded and Peaty Gleysol soil sub-groups. Only the orthic type, designated as the Pipun series, occurs in mappable areas. No descriptions of the other two series are given since they are too variable and, furthermore, they are too small in area to be significant. In the areas examined, these soils, in the clay portion of the profile have the morphological characteristics of the thicker lacustrine clays of similar drainage. Under the clay, the unconforming substrate of lacustrine silt is similar to the parent material of the Minago and Dunlop soil series.

PIPUN SERIES (1,035 acres)

The Pipun series is a moderately well drained, Orthic Grey Wooded clay soil with strongly developed, shot-like or sub-angular blocky structure in the A_2 horizon and with strongly developed, blocky structure in the B horizon. The solum of these soils usually extends downward to the underlying silty sediments, particularly if the clay covering is less than 20 inches thick.

The terrain occupied by these soils is ridge-like or very gently to gently sloping. Internal drainage is good through the well-structured clay, but is somewhat restricted by the compacted silt under the clay. The vegetation consists mainly of spruce; relatively pure stands of aspen occur in localized areas.

A description of the representative Pipun soil profile is given below:

O —Very dark brown (dry and moist) leaf and moss mat, partly decomposed (2 to 4 inches thick); medium acid.

A_2—Light brownish grey (dry) to greyish brown (moist) clay (1 to 3 inches thick); strongly developed, medium shotty to fine sub-angular blocky structure; sticky and plastic when wet, very hard when dry; medium acid.

B_1—Dark brownish grey (dry) to dark grey (moist) clay (1 to 4 inches thick); strongly developed, medium sub-angular blocky structure; sticky and plastic when moist, very hard when dry; medium acid.

B_2—Dark yellowish brown (dry) to very dark greyish brown (moist) clay (2 to 8 inches thick); strongly developed, medium blocky structure; plastic and sticky when wet, very hard when dry; medium acid.

B_3—Brown (dry) to dark greyish brown (moist) clay (1 to 4 inches thick); medium developed, fine blocky structure; sticky and plastic when wet, hard when dry; mildly alkaline. Horizon may be absent.

C —Very pale brown (dry) to brown (moist) clay; fine pseudo-granular; sticky and plastic when wet, hard when dry; moderately alkaline; calcareous. Horizon may be absent.

D —Light grey (dry) to greyish brown (moist) silt loam; fine pseudo-granular; slightly sticky when wet, soft when dry; strongly calcareous; stratified.

Mapping Complexes:

Pipun soils were mapped in a few small areas in association with a minor percentage of Wabowden and Half Bog soils. Other very small areas of Pipun soils were identified but were too small to separate from the surrounding soil complex.

Analysis and Fertility:

The chemical and physical characteristics of the Pipun soil, in the clay portion of the profile, are expected to be similar to the Wabowden or Sipiwesk series and, in the silt portion, similar to the parent material of the Minago series. Where the clay mantle is thin, the surface material is slightly higher in reaction than in soils with a thick clay covering. Acidity is not expected to be a problem for such crops as alfalfa because of the proximity to the surface of the limy substrate.

SOILS DEVELOPED ON LACUSTRINE SILT

The soils developed on silt deposits in the surveyed section occur in small scattered areas, mainly west and south of the town of Wabowden. The largest acreage in the surveyed area is near Kiski Creek. Previous investigations of the clay region revealed a large tract of thick silty deposits in the Hill Lake region through which the Minago River flows. There the deposits are much thicker by comparison than those occurring in the surveyed area.

The soils in this group are developed on well-sorted, strongly calcareous sediments with textures that range from silt loam to silty clay loam. Three genetic types were recognized, namely: Orthic Grey Wooded, Gleyed Grey Wooded and Peaty Gleysol. Only the Orthic Grey Wooded, called the Minago series, and the Peaty Gleysol, called the Dunlop series, occur in mappable proportions. The Gleyed Grey Wooded, which is not described, is similar to the better drained soil in the main morphological features.

MINAGO SERIES (70 acres)

The Minago series is an Orthic Grey Wooded soil with a thin solum not exceeding 10 inches in total thickness. This thin solum, which is characteristic of soils developed from strongly calcareous material, has distinct horizons with the normal features of a Grey Wooded soil.

The topography is irregular, very gently to gently sloping, except in areas where some dissection by water courses has occurred. Indigneous vegetation is dominantly jack pine followed by spruce, aspen and birch. Internal drainage is moderate, yet sufficiently rapid under the local climatic conditions to impart favourable soil drainage conditions. Permeability may be temporarily reduced by cementation of the silty sediments during a prolonged dry period. This cementation however is reversible on wetting.

A generalized profile description of the Minago series is given below:

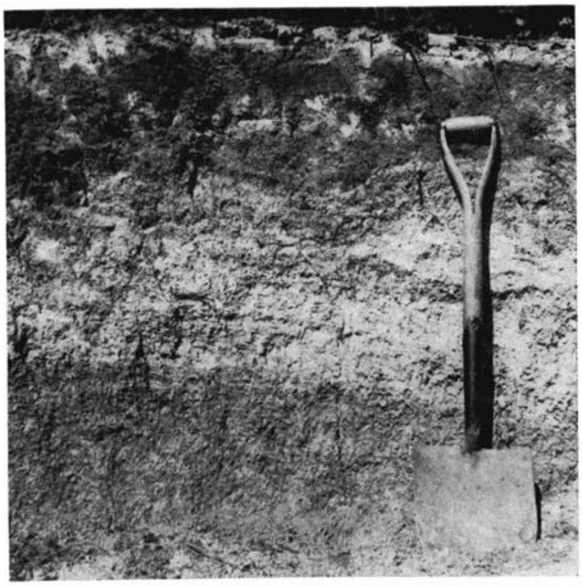


FIGURE 18

Soil profile of Minago silt loam. An Orthic Grey Wooded soil developed on strongly calcareous deltaic deposits.

O —Very dark brown (dry and moist) leaf mat (1 to 3 inches thick); moderately well decomposed; medium acid.

A_2—Greyish brown (dry) to dark greyish brown (moist) very fine sandy loam to silt loam (.5 to 2 inches thick); weakly developed, fine platy structure; soft; medium acid.

B —Dark greyish brown (dry) to very dark greyish brown (moist) silty clay loam (2 to 8 inches thick); medium granular to fine sub-angular blocky; sticky and plastic when wet, slightly hard when dry; slightly acid.

C —Light grey (dry) to greyish brown (moist) silt loam to silty clay loam; fine pseudo-granular; sticky when wet, cemented when dry; strongly calcareous, moderately alkaline.

Mapping Complexes:

The small areas of Minago soils that were separated were mapped as a complex with about 40 to 60 percent of Wabowden, Half Bog and other soils. Other small areas of Minago soils were identified but were included with the surrounding soil complex.

Analysis and Fertility:

The Minago silt loam is a thin soil that is very low in natural fertility (see Table 13). The solum of this soil seldom exceeds 10 inches in total thickness and it is underlain with strongly calcareous materials containing more than 35 percent calcium carbonate equivalent. When this soil is cleared of forest cover with a bulldozer, care must be exercised to avoid removing any of the surface soil. Initially the organic matter content is low and the removal of the leaf mat and some surface soil impoverishes this soil to a considerable extent. If a bulldozer is used in clearing, it is recommended that the work be done after the ground is frozen. In addition to low organic matter content this soil is low in nitrogen and phosphate. Calcium and magnesium are in plentiful supply but potassium is low. No lime is required.

TABLE 13

Analysis of Mingo Silt Loam

Horizon	O	A_2	B_2	C_1	C_2
Depth (inches)	2–0	0–2	2–5	5–15	15+
Moisture Equivalent	92.5	35.4	33.9	25.6	25.0
Sand (%)	...	9.7	10.1	...	.4
Silt (%)	...	71.4	68.9	...	84.3
Clay (%)	...	18.9	21.0	...	15.3
Organic Carbon (%)	33.47	3.49	2.76	.21	.14
Total Nitrogen (%)	1.19	.15	.13	.02	.01
C/N Ratio	...	...	...	...	...
Total P (%)	.06	.02	.02	.03	.03
Available P (P.P.M.)	28	12	10	...	...
Total SO_3 (%)	.18	.01	.01	.02	.02
Inorganic CO_3 (%)	...	1.17	2.88	23.90	24.84
pH Values	5.8	6.9	7.4	8.0	8.1
Exch. Cap. (m.e.)	...	28.2	24.8	...	...
Exch. Ca. (m.e.)	...	19.9	18.6	...	...
Exch. Mg. (m.e.)	...	6.8	5.8	...	...
Exch. Na. (m.e.)	...	.3	.1	...	...
Exch. K. (m.e.)	...	.5	.3	...	...
Exch. H. (m.e.)	17.6	.9	...	...	...
Conductivity (mmhos)	...	...	.6	.5	...

DUNLOP SERIES (120 acres)

The Dunlop series is a Peaty Gleysol with 6 to 12 inches of peat and with a well-developed gley horizon under the organic mantle. A thin A_1 horizon, high in organic matter, is present in some soils.

The Dunlop soils occur in some of the depressional areas and in narrow strips around some of the organic soils. The topography is level to very gently sloping. Vegetation is mainly black spruce and tamarack with some clumps of willow and black alder. Ground cover is dominated by mosses of various kinds.

Internal drainage is poor for the greater part of the year because of a high water table. Permeability of this soil is only fair due to stratification planes and close packing of the sediments.

A description of the representative Dunlop soil profile is given below:

O —Very dark brown (dry and moist) organic layer (6 to 12 inches thick); moderately decomposed in the lower portion; medium acid.

A_1—Very dark grey (moist) silt loam to silty clay loam (< 2 inches thick); fine granular; sticky and moderately plastic; neutral to mildly alkaline. Horizon is usually absent.

Cg—Light greyish brown (dry) to greyish brown (moist) silt loam to silty clay loam (4 to 12 inches thick); fine pseudo-crumb structure; very sticky and plastic when wet, hard when dry; strongly gleyed; moderately alkaline; moderately calcareous; iron stained.

C_2—Light grey (dry) to light brownish grey (moist) silt loam to silty clay loam; fine pseudo-crumb structure; very sticky and plastic when wet, hard when dry; strongly calcareous; iron stained; weakly gleyed.

Mapping Complexes:

The few small areas of Dunlop soils that were separated contain a minor percentage of other soils—mainly Half Bog. Dunlop soils were also identified in local sites within areas of other soil complexes.

Analysis and Fertility:

The Dunlop soil is a peaty, poorly drained soil low in natural fertility (see Table 14). Its management problems, like the Medard soil, are artificial drainage, incorporation of the peaty surface with the mineral soil and fertilization of crops with nitrogen and phosphate.

TABLE 14

Analysis of Dunlop Silt Loam

Horizon	O	Cg	C_2
Depth (inches)	8–0	0–6	6+
Moisture Equivalent	132.5	26.3	21.4
Sand (%)	....	6.0	2.2
Silt (%)	....	67.8	84.6
Clay (%)	....	26.2	13.2
Organic Carbon (%)	36.48	.49	.02
Total Nitrogen (%)	1.13	.04	.02
C/N Ratio	....	12.2	10.0
Total P (%)	.08	.02	.03
Available P (P.P.M.)	28	4	....
Total SO_3 (%)	.14	.02	.01
Inorganic CO_3 (%)	....	14.89	23.73
pH Values	6.3	7.8	8.1
Exch. Cap. (m.e.)	....	17.2	....
Exch. Ca. (m.e.)	....	12.2	....
Exch. Mg. (m.e.)	....	4.4	....
Exch. Na. (m.e.)	....	.2	....
Exch. K. (m.e.)	....	.4	....
Exch. H. (m.e.)	8.7	....	....
Conductivity (mmhos)	....	.4	.4

SOILS DEVELOPED ON SAND

Sand deposits cover a small area in the surveyed section and occur in bar and beach-like land forms. The main deposits are located south of the railway at Mile 127 and at Mile 143.7. At both points the sand was partially removed by the Railway Company for grade ballast. Where the material was removed the original deposits likely did not exceed a thickness of 15 feet. At the sites investigated the sand is underlain with clay.

The total area covered by the sand deposits in the surveyed section is approximately 0.6 percent. This area is dominantly well drained due to greater relief in relation to the bordering clay soils. Imperfectly drained soils occur only in small occluded areas, consequently no separation has been made on the soil map. The soils developed on the sandy sediments are classified as Podzols. Two soils, the Orthic Podzol and the Gleyed Podzol respectively named the Clarke series and the Pakwa series, are described in the report. Some poorly drained sandy soils and some Half Bog soils with a sand substrate were noted at a few points.

CLARKE SERIES (3,500 acres)

The Clarke series is a well-drained, Orthic Podzol developed on medium to find sand sediments. These sediments were derived mainly from granitoid rocks through the action of glacial agencies. In these sediments, the lime carbonate that was originally present after the recession of lake waters has been leached down to the ground water zone.

The Clarke soil profile has a prominent A_2 horizon and has a friable B horizon with a weak concentration of iron and organic matter. The C horizon is acid to a depth of 4 to 5 feet, where traces of lime carbonate are encountered.

The ridge-like deposits have a vegetative cover consisting mainly of a jack pine canopy with a ground cover of various mosses. Internal drainage is excessive, however no serious droughty conditions are indicated by the tree cover.

A profile description of the Clarke series is given below:

FIGURE 19

Soil profile of Clarke sand. An Orthic Podzol soil developed on sandy deltaic deposits.

O —Very dark grey (dry) to black (moist) leaf mat (1 to 3 inches thick); weakly decomposed; strongly acid.

A_2—Light grey (dry) to grey (moist) sand (4 to 7 inches thick); structureless; loose; strongly acid.

B_2—Light yellowish brown (dry) to yellowish brown (moist) sand to fine sand (5 to 8 inches thick); structureless; weakly cemented when dry; strongly acid.

B_3—Yellow (dry) to brownish yellow (moist) sand to fine sand (4 to 10 inches thick); structureless; loose; strongly acid.

C —Light grey (dry) to light brownish grey (moist) sand; structureless; loose; strongly acid. Some lime carbonate occurs at depths exceeding 4 feet.

Mapping Complexes:

The areas mapped as Clarke and others are predominately composed of Clarke soils, but contain small occluded areas of Pakwa soils, poorly drained sandy soils and Half Bog.

Analysis and Fertility:

The Clarke series is composed of coarse textured soils very low in organic matter, nitrogen, phosphate, sulphur, calcium and potassium, and strongly acid to a depth of four or more feet (see Table 15). This soil may be more suitable than the finer textured types for vegetables and small fruits if supplied with lime, organic matter and the major plant nutrients. If limed, this soil may be suitable for legumes. One advantage of sandy soils in this northern area, over the fine textured types, is that they will warm up more quickly in the spring season. This advantage in soil temperature results in more rapid growth of crops and a hastening of maturity.

PAKWA SERIES

The Pakwa series is a Gleyed Podzol containing free lime carbonate in the upper part of the C horizon where the ground water level fluctuates. In this soil, the B horizon is friable and contains iron and some organic matter.

TABLE 15

Analysis of Clarke Sand

Horizon	O	A_2	B_2	B_3	C_1	C_2	Cca	Cca
Depth (inches)	1.0	0–5	5–11	11–20	20–48	48–60	60–120	120+
Moisture Equivalent	86.6	5.4	5.0	1.7	1.4	1.2	3.3	3.3
Sand (%)	...	91.9	95.5	...	...	...	93.7	...
Silt (%)	...	4.4	1.0	...	...	...	1.2	...
Clay (%)	...	3.7	3.5	...	...	...	5.1	...
Organic Carbon (%)	33.78	.51	.37	.10	...	...	...	...
Total Nitrogen (%)	.91	.02	.02	...	...	...	...	...
C/N Ratio	...	...	...	...	...	...	...	...
Total P (%)	.07	.01	.05	.02	.02	.03	.04	.03
Available P (P.P.M.)	34	14	8	...	...	...	...	...
Total SO_3 (%)	.12	.01	.01	.02	.01	.01	.02	.01
Inorganic CO_3 (%)	...	...	...	...	...	...	1.31	4.25
pH Values	5.1	4.2	5.4	5.5	5.7	6.0	7.1	7.9
Exch. Cap. (m.e.)	...	4.7	3.9	1.9	...	2.0	1.5	...
Exch. Ca. (m.e.)	...	.5	.5	.3	...	.3	.4	...
Exch. Mg. (m.e.)	...	.7	.7	.7	...	.9	.9	...
Exch. Na. (m.e.)	...	.1	.2	.1	...	.1	.1	...
Exch. K. (m.e.)	...	.1	.1	.1	...	.1	.1	...
Exch. H. (m.e.)	30.3	3.3	2.4	.7	.5	.6	...	...

No clay concentration in the B horizon is evident. The C horizon is gleyed, iron stained and contains small amounts of free lime carbonate.

The Pakwa soils have a vegetative cover consisting chiefly of jack pine, spruce and aspen. Permeability is very rapid, but drainage is impeded by the water table that occurs within a few feet of the surface.

A profile description of the Pakwa series is given below:

O —Very dark greyish brown (dry and moist) leaf mat (2 to 5 inches thick); weakly decomposed; strongly acid.

A_2—White (dry) to light grey (moist) sand to fine sand (2 to 5 inches thick); structureless; loose; strongly acid.

B_1—Light greyish brown (dry) to brown (moist) sand to fine sand (2 to 4 inches thick); structureless; loose; strongly acid.

B_2—Yellowish brown (dry) to strong brown (moist) sand to fine sand (5 to 8 inches thick); structureless; weakly cemented when dry; very friable when moist; medium acid.

C_1—Pale brown (dry) to brown (moist) sand to fine sand (2 to 10 inches thick); structureless; loose; neutral; iron stained.

C_2—Brown (dry) to yellowish brown (moist) sand to fine sand (6 to 15 inches thick); structureless; loose; iron stained; mildly alkaline.

Cca—Light grey (dry) to greyish brown (moist) sand to fine sand; structureless; loose; calcareous and iron stained.

Mapping Complexes:

The small areas of Pakwa soils that were identified were included with the surrounding Clarke soils in the Clarke and others complex.

Analysis and Fertility:

The Pakwa series consists of coarse textured soils that are very low in natural fertility (see Table 16). Their problems are similar to the Clarke soils and these soils can be managed in a similar manner. Both these soils may be suitable for forage crops, vegetables and small fruits if organic matter, fertilizers and lime are applied.

TABLE 16

Analysis of Pakwa Sand

Horizon	O	A_2	B_1	B_2	C_1	C_2	Cca
Depth (inches)	2–0	0–3	3–5	5–11	11–17	17–25	25+
Moisture Equivalent	115.0	7.8	4.6	3.2	4.4	4.3	3.5
Sand (%)	...	90.8	...	94.5	...	85.7	86.0
Silt (%)	...	5.3	...	2.1	...	8.6	11.2
Clay (%)	...	3.9	...	3.4	...	5.7	2.8
Organic Carbon (%)	39.53	1.16	.28	.31	.14	.09	.04
Total Nitrogen (%)	.85	.04	.03	.03	.01	...	...
C/N Ratio	...	...	9.3	10.3	...	...	...
Total P (%)	.07	.01	.01	.02	.05	.06	.05
Available P (P.P.M.)	38	2	...	...	...	...	...
Total SO_3 (%)	.17	.01	.01	.01	.01	.01	.01
Inorganic CO_3 (%)	...	...	...	...	.12	.21	5.44
pH Values	4.4	3.8	4.7	5.5	7.0	7.4	8.2
Exch. Cap. (m.e.)	...	6.9	3.9	3.8	4.8	...	...
Exch. Ca. (m.e.)	...	1.2	1.0	1.4	3.0	...	...
Exch. Mg. (m.e.)	...	.9	.9	.9	1.6	...	...
Exch. Na. (m.e.)	...	.1	.1	.1	.1	...	...
Exch. K. (m.e.)	...	.1	.1	.1	.1	...	...
Exch. H. (m.e.)	41.8	4.6	1.8	1.3	...	...	...

ORGANIC SOILS

The organic soils, with peaty materials exceeding 12 inches in thickness, cover approximately 51 percent of the mapped area. These soils occur in large tracts and in small areas intermingled with the better drained soils.

The organic residues are composed of mosses, grasses, grass-like and woody materials that are moderately decomposed and strongly acid in reaction. Decompostion of materials increases with depth and the organic layer has black humified appearance near and at the contact with the underlying mineral sediments. The mineral sediments under the peat are dominantly clay; silt and sand substrata occur in areas bordering the better drained mineral soils with those respective textures. On the basis of peat thickness, two soils, namely, Half Bog and Bog were mapped.

HALF BOG (65,825 acres)

The Half Bog soils contain 12 to 30 inches of organic materials in various stages of decomposition. In general the composition of the peat is fairly uniform throughout this clay region. The peat is composed of a mixture of moss, fen and woody materials; the latter consists of tamarack and black spruce trees that dominate the forest cover in the wet sites.

Mapping Complexes:

The Half Bog soils are widespread but are most prominent on the western margin of the mapped area. In general, these soils occur in small areas and most of them were mapped as part of the various soil complexes, especially with the Wabowden series (see Table 8). Approximately 12,500 acres were mapped separately as consisting of over 80 percent of Half Bog soils.

Analysis and Fertility:

The Half Bog soils are very low in natural fertility. The peat layer is strongly acid in reaction and, in its natural state, is very low in available plant nutrients. The underlying clay material contains very little organic matter and is low in available nitrogen, phosphate and sulphur. If these soils are to be cultivated, after artificial drainage has been provided, the peat layer should not be destroyed but should be incorporated with the mineral material. Heavy fertilization would be required for production of coarse grain and forage crops.

BOG (214,570 acres)

The Bog soils contain more than 30 inches of organic materials in various stages of decomposition. These soils are generally lower in woody materials than the Half Bog types. It is assumed that the lower part of the soils formed entirely from grass and grass-like plants and the upper part from a mixture of fen, moss and woody substances. Thick deposits of organic materials, exceeding 10 feet, were noted at a few sites along the railway. At these sites, the soils have a covering of strongly acid, raw organic matter underlain with black humified material that increases in decomposition with depth. This humified material appears to be an excellent source of organic matter for mineral soils, and could be used as an additive to increase the organic matter content of cultivated mineral soils. The forest cover, consisting mainly of tamarack, is usually thin and stunted and sometimes absent. Thin stands of trees are common in low areas containing stagnant water. Along streams where oxygenated water occurs, the stands of trees are much superior.

Mapping Complexes:

Bog soils are widespread in the surveyed area and are most extensive east of Odhill (Mile 159). In the western portion, areas of these soils are generally smaller in extent than those in the eastern section. Many of the smaller areas, that were not mappable, were included with, and are parts of the various soil complexes. Conversely, many unmappable areas of other soils have been included with the Bog soils.

Analysis and Fertility:

The Bog soils, in their natural state, are low in fertility. Reclamation of these soils for cultivation would be very difficult. Extensive drainage works would be necessary and many problems would be encountered in attempts to cultivate the deep peat layer. The organic layer should not be destroyed by fire as the underlying mineral material is mostly heavy clay, which is very low in organic material and available plant nutrients.

ROCKLAND (15,885 acres)

Rockland consists of bare rock outcrop and very thin deposits of unconsolidated material over rock. This rock occurs in small, usually elongated, ridges within the clay and peat tracts and as low cliffs near and at the shores of lakes. In many places the rock outcrop is less than an acre in area and is shown on the map as a complex with the Wabowden soils or is indicated by a symbol. In general, the largest areas occur near lakes and the more prominent streams.

FIGURE 20

A miniature Grey Wooded soil developed on five inches of clay underlain with granitoid bedrock.

Where the unconsolidated mantle exceeds a few inches in thickness miniature soil profiles have developed. Most commonly, these miniature soils have formed in clay and are of the Grey Wooded type with shot-like and subangular blocky structures. In some places, the material over rock consists of two to three inches of organic residues derived from mosses common to that region.

Drainage of the thin soils on the slopes of the rock bosses is naturally good and soil development is distinct. In the depressional portions of the rockland drainage is restricted, thus favouring the formation of peat rather than the profile development of the mineral material. The latter condition however is of minor occurrence in this land type.

PART III

AGRICULTURE

A. ESTIMATED SUITABILITY OF SOILS FOR AGRICULTURAL USE

Estimated suitability of the soils in the clay area for various purposes is shown in Table 17. The ratings contained in the table are based on general observations and on a study of the characteristics expressed in the individual soil profiles. These ratings are not based on yields (which are not available) but represent the considered opinions of the soil surveyors. In all cases, the frost hazard is considered both on the basis of the climatic data available and on the observations of the few crops grown at various points in the clay region.

TABLE 17

Estimated Suitability[1] of Soils for Agricultural Use

Soil Designation	Grain Crops				Hay Crops		Garden Crops and Fruit			
	Wheat	Oats	Barley	Flax	Grasses	Legumes	[2] Roots and Potatoes	Cabbage and Lettuce	[3] Other Vegetables	[4] Fruit
Wabowden Series	P-F	F	F	F	F-G	G-F	F-G	G-F	F-P	F-G
Sipiwesk Series	P-F	F	F	F	F-G	G-F	G-F	G-F	F-P	F-G
La Perouse Series	N	N	N	N	F	N	P	P	P	P
Medard Series	N	N	N	N	F	N	P	P	P	P
Pipun Series	P-F	F	F	F	F-G	G-F	F	F-G	F	F-G
Minago Series	P-F	P-F	P-F	F	F	F-G	F	F	VP	P-F
Dunlop	N	N	N	N	F	N	P	P	P	P
Clarke Series	N	N	N	N	P	F	P-F	F	F	F
Pakwa Series	N	N	N	N	F	F	P-F	F	F	F

[1]Symbols: G = good; G-F = good to fair; F-G = fair to good; F = fair; F-P = fair to poor; P-F = poor to fair; P = poor; VP = very poor; N = not suitable.

[2]Roots include: turnips, beets, carrots and radishes.

[3]Other vegetables include: beans, peas, onions and tomatoes.

[4]Fruit includes: raspberries, currants, gooseberries and strawberries.

B. AGRICULTURAL POTENTIAL

The agricultural possibilities of the northern clay belt, at present, appear to be limited. The principal limiting factors are frost hazard, low arable acreage and low natural fertility of the soils.

The frost hazard appears to be the most important problem. No serious frost damage to coarse grains has occurred on the Wabowden Experimental Sub-Station farm since its establishment in 1954, however killing frosts were reported by local inhabitants at other points in the clay area. At Wabowden, weather recordings for the last 12 years indicate an average frost-free period (above 32°F) of 90 days. During this interval the frost-free periods ranged from 68 days in 1945 to 109 days in 1953. A shorter frost-free period is expected at more northerly points and in sites located two or more miles from sizeable lakes. Widespread clearing may reduce the frost hazard to a limited extent on the uplands. No substantial clearing however can be anticipated because of the limited arable acreage. It is expected that killing frosts will result in complete losses of cereal grains in some years.

The low arable acreage due to rock, peat and water, is a serious deterrent to settlement. Presently it is estimated that less than 20 percent of the total clay area of approximately seven million acres is arable; that is, imperfectly drained or better. Arable acreage per quarter section ranges from none to about 80 acres. Surface drainage of most thin peat soils is presently impractical because of the cost of constructing good drains. Generally, the drains would have to follow depressional areas; rarely will it be possible to cut a ditch through an elevated portion due to the proximity to the surface of granitic bedrock.

The low natural fertility of the arable soils is due primarily to deficiencies of organic matter, nitrogen, phosphate and sulphur. The clay soils are strongly acid in the surface horizons, but yield response to liming has not been verified by experimentation in this area. At the Wabowden station, fertilizer treatments consisting of nitrogen, phosphate, potassium, sulphur and a few minor elements have been

FIGURE 21

View of new breaking in 1954 of Wabowden clay on the station farm. The light colored surface soil consists mainly of the original leached A_2 horizon.

FIGURE 22

Unfertilized plots of grain and flax grown on the Wabowden Experimental Sub-Station.

Figure 23

Fertilized versus unfertilized barley plots on the Wabowden Experimental Sub-Station.

Figure 24

Unfertilized yellow blossom sweet clover grown on the Wabowden Experimental Sub-Station in 1956.

applied only to barley, and the indications are that the response attained is attributable primarily to nitrogen and phosphate. It is expected that liming and applying sulphur to

Figure 25

Unfertilized alfalfa grown on the Wabowden Experimental Sub-Station.

alfalfa on clay soils will induce some response in the initial stages of growth. Under present conditions alfalfa is slow in developing good stands until the third year after seeding. It appears that its maximum growth occurs after the roots contact the calcareous parent material. Other forage crops such as sweet clover, alsike, red clover, brome and other grasses have produced reasonably well without fertilizers when favourable germination was attained.

Germination of seeds is a serious problem in clay soils low in organic matter. It is expected that this problem can be largely overcome by packing the soil immediately after seeding.

Clearing of forest with the bulldozer in preparation for breaking is another problem that requires consideration. In most instances the clearing with the bulldozer results in the removal of the leaf mat and some of the surface horizons. This manner of clearing is deleterious to the fertility of the soil and thus every effort should be exercised to retain as much of the leaf litter as possible. In some areas however most of the organic layer has been destroyed by fires.

Without question, more information is required regarding the production of grain, forage, vegetable and small fruit crops under the existing climatic conditions. It has been demonstrated at Cross Lake and at Wabowden that barley and oats can be grown with reasonable success in years not assailed by killing frosts during the growing period. Large increases in yields of barley, where ammonium phosphate fertilizers have been applied, have been obtained on the Wabowden station. It is assumed that yield increases with fertilizer applications also can be attained with forage crops and vegetables. Vegetables such as potatoes, cabbage, turnips, carrots, radishes, lettuce and others have been successfully grown over a period of years at Cross Lake, Wabowden, Thicket Portage and Nelson House. Tomatoes, a very susceptible crop to frost injury, have been grown at Cross Lake for

FIGURE 27

Cabbages and Potatoes grown at Nelson House (September 15, 1952).

FIGURE 26

Potatoes grown at Wabowden by Mr. Davidson in 1957.

FIGURE 28

Cabbage grown at Lyddal (Mile 149).

many years. Small fruits such as raspberries, strawberries, currants and gooseberries can be grown at most points.

In all cases however, good cultural treatments are required to obtain favourable returns. Fertilizers and the application of organic matter in the form of decomposed peat can increase yields to a considerable extent in years when frost is not a factor.

Much is yet to be learned about this area and it is hoped that the Experimental Sub-Station at Wabowden will provide the basic information on the cultural aspects of the soils. Information on various crops and on climate also is required on more northerly areas of the clay region. Locations suggested for various test plots are at Thicket Portage, Pikwitonei and Nelson House.

FIGURE 29

Ripe tomatoes at Cross Lake Mission (September 15, 1952).