SOIL SURVEY OF CARLETON COUNTY

PROVINCE OF ONTARIO

●

BY

G. A. HILLS and N. R. RICHARDS

EXPERIMENTAL FARMS SERVICE

AND

F. F. MORWICK

ONTARIO AGRICULTURAL COLLEGE

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GUELPH, ONTARIO

MARCH 1944

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EXPERIMENTAL FARMS SERVICE, DOMINION DEPARTMENT OF AGRICULTURE AND THE ONTARIO AGRICULTURAL COLLEGE

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PREFACE

The soils of Carleton County were surveyed during the summer and fall months of 1940. This is the seventeenth county for which a soil map has been prepared on a detailed reconnaissance basis, and it is the first county for which a complete Soil Survey Report has been published. Six county soil maps have been published previously, namely—Norfolk, Elgin, Kent, Haldimand, Welland and Middlesex. These have been numbered in order from one to six, and for this reason this soil report and map has been numbered seven.

The other counties which have been surveyed and maps prepared are as follows—Essex, Oxford, Brant, Waterloo, Wentworth, Lincoln, Halton, Peel, York, Dufferin, Durham, Peterboro, Northumberland, Prince Edward and Grenville. Copies of the maps for each of these counties have been placed in the respective Agricultural Representatives' offices.

ONTARIO SOIL SURVEY COMMITTEE

●

DOMINION DEPARTMENT OF AGRICULTURE
EXPERIMENTAL FARMS SERVICE

DR. E. S. ARCHIBALD — DR. A. LEAHEY
DR. E. S. HOPKINS — MR. L. E. WRIGHT

ONTARIO DEPARTMENT OF AGRICULTURE
ONTARIO AGRICULTURAL COLLEGE

DR. G. I. CHRISTIE — PROF. G. N. LUHNKE
PROF. F. F. MORWICK

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The physical and chemical analyses were done by Messrs. A. S. Fleming and A. L. Willis.

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PART I

GENERAL DESCRIPTION OF AREA

Location and Area

Carleton County is located on the southern shore of the Ottawa River in Eastern Ontario. It lies between Russell County on the east and Lanark County on the west, while adjoining it on the south are the counties of Grenville and Dundas. Renfrew County shares a common border for about three miles in the northwest corner. (See map showing location.) The city of Ottawa, situated on the Ottawa River in the northeast section of the county, is 283 miles from Toronto and 126 miles from Montreal.

The area of the county is approximately 947 square miles, 606,000 acres (Seventh Census of Canada, 1931). As this includes some fairly broad expanses of water in the Ottawa and Rideau Rivers, the total land area is approximately 585,600 acres. Of this, approximately 562,000 acres is assessed land, the remainder being taken up by roads, etc.

County Seat and Principal Towns

The city of Ottawa, Capital of the Dominion of Canada and county seat of Carleton County, is situated at the junction of the Ottawa River and Rideau Canal. The Gothic towers of Parliament Hill dominate the city that has grown from an engineering camp of a century ago to the national Capital of today. The office of the county agricultural representative is located here, and the Central Experimental Farm adjoins the city to the west.

Richmond, located in Goulbourn Township, is an incorporated village, having a population of 405. There are several smaller villages, the most important being North Gower, Osgoode Station, Manotick Station and Metcalfe in the southern section of the county, while Carp and Orleans are located in the north. (See Figure 2.)

Population and Racial Origin

The total population of Carleton County as recorded by the 1931 Census was 170,040 persons, of whom 10.9 per cent or 18,552 were on farms. The population of the organized municipalities of the Ottawa urban area totals 134,569 persons. In addition, a large proportion of the rural non-farm population (16,574) live in this suburban district.

The British are the dominant racial class, but several others are represented. The majority of the French are found in the Ottawa urban area and in the eastern part of Gloucester and Osgoode Townships. The following figures from the 1931 Census indicate the racial class proportion:

Total Population	170,040	100.0%
British	107,979	63.5%
French	48,100	28.2%
All Others	13,961	8.3%

Transportation and Markets

Carleton County is well supplied with roads and railways connecting the more densely populated urban area with the farming districts. A glance at the map shows that Ottawa is the centre from which the main roads radiate. Ottawa is, by far, the largest centre of population and affords an excellent market for the district. The towns of Arnprior, Carleton Place, and Kemptville located close to the border of the adjoining counties of Renfrew, Lanark and Dundas also serve as marketing centres for Carleton County.

Highway No. 17 running parallel to the Ottawa River traverses Gloucester Township and joins the cities of Montreal and Ottawa. Continuing from Ottawa through the northerly section of Nepean Township, it follows through the fertile farm lands of the Carp Valley in Huntley and Fitzroy Townships.

Running parallel to the Rideau River, Highway No. 16 serves North Gower and Nepean Townships, while Highway No. 15 traverses Goulbourn Township. In addition to the main arteries of travel mentioned above, the county supports an excellent network of county highways and township roads.

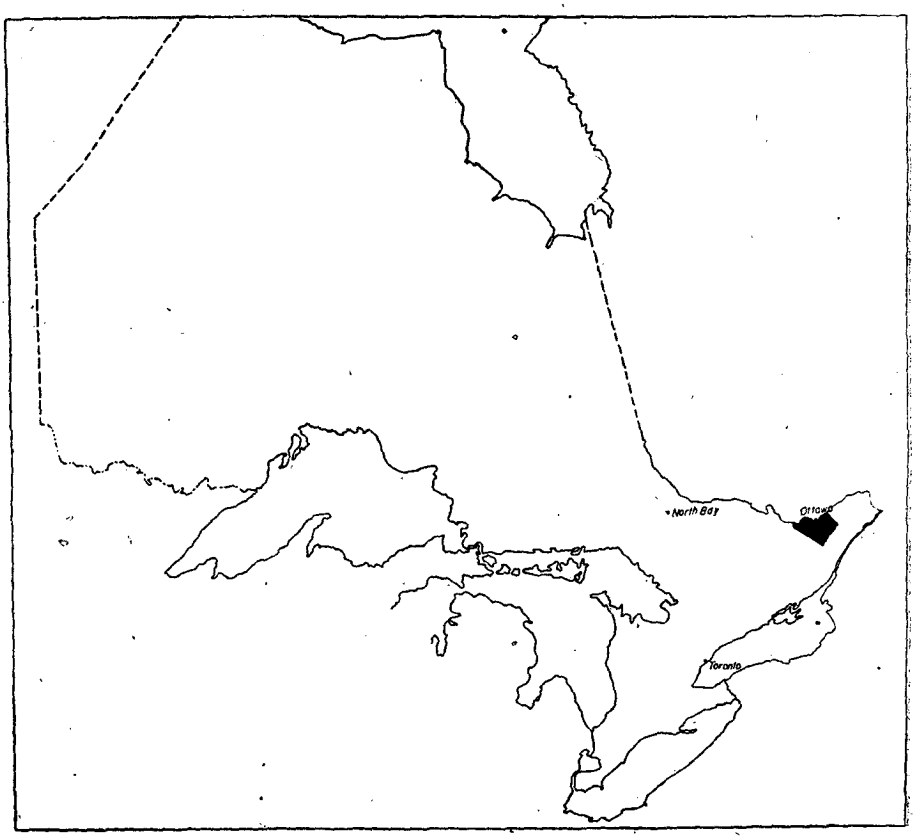


FIG. 1—Map showing the location of Carleton County within the Province of Ontario.

Both the Canadian National and Canadian Pacific Railway lines from Ottawa to Montreal traverse Gloucester Township in close proximity to Mer Bleue. Three other lines of these companies join Ottawa with Kemptville, Carleton Place and Smith Falls and points west, providing transportation facilities for the southern and central section of the county. The Ottawa to North Bay line of the Canadian National Railway serves the agricultural areas of Fitzroy, Huntley and March Townships in the northwest of the county. Ottawa and a number of local points in the eastern part of the county are served by a line of the New York Central Railway. With such transportation facilities as these, there is no difficulty in getting farm products to market.

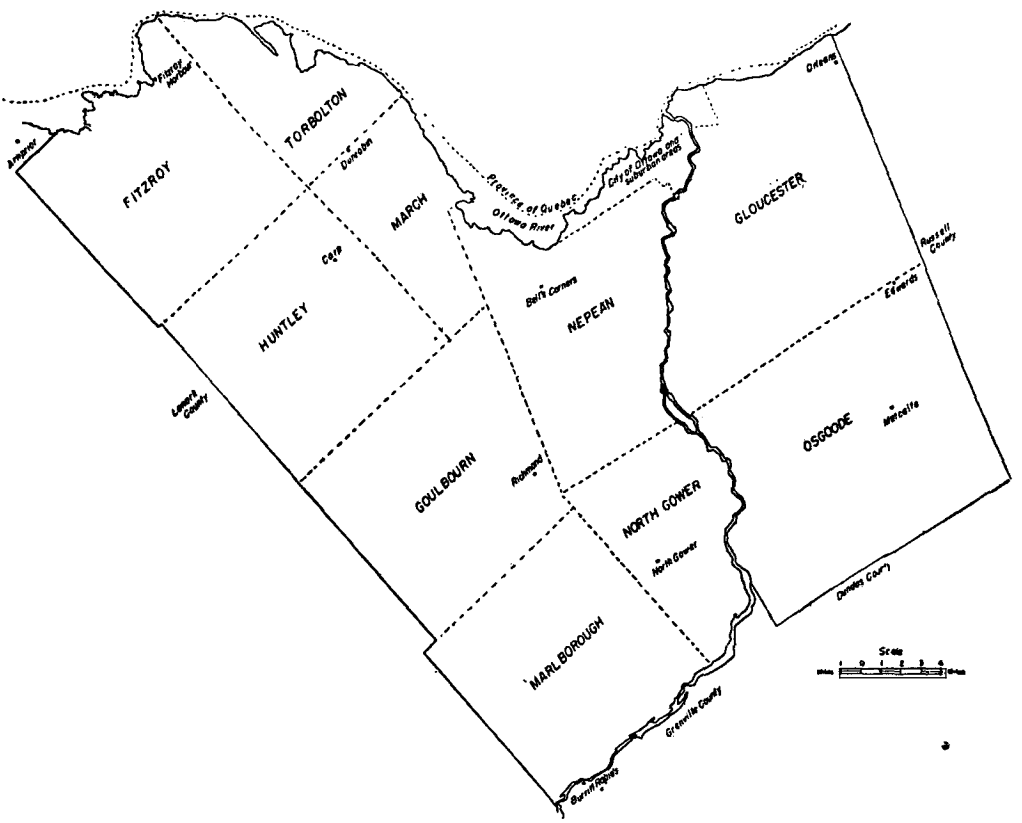


FIG. 2—Map of Carleton County showing location of the townships and some of the marketing centres.

PART II

FACTORS AFFECTING THE FORMATION OF CARLETON COUNTY SOILS

Soils are natural bodies found at the surface of the earth and constitute the natural media in which plants grow. Disintegrated rock particles constitute the soil skeleton within which the active clay and humus colloids are formed through the action of climate and living organisms. Regional soil features change with regional differences in climate and associated natural vegetation and other organisms. A climatic soil zone is comprised of soils reflecting the regional environment. Within a climatic soil zone there are local differences in soil development resulting from local environmental factors, such as the type of the parent soil materials, the soil water, and local differences in vegetation. The time during which these forces have been operating also greatly affects the nature of the soil.

The Geological Materials upon which Carleton County Soils Have Been Formed

As soils develop within the geological deposits found at the surface of the earth, many of their characteristics are determined by the nature of these "parent materials." An important factor is "geologic structure," which concerns the size and shape of the particles or fragments and the way in which they are arranged. The structural types occurring in the area may be roughly divided into two groups: (*a*) the unassorted tills laid down by glaciers; (*b*) the sorted clays, silts, sands and gravels laid down by water. These groups may be again subdivided. The tills are differentiated on the size and quality of stones and the nature of the finer materials between them. The sorted water-laid materials are subdivided on the basis of size of particles and on the type of layers or stratification. Another important characteristic of parent materials, which has a strong influence on soil type, is chemical composition. The soil materials of Ontario may be grouped into three main classes according to the influence of their chemical composition on soil development: (*a*) Calcareous materials, rich in lime, found in large proportions in limestone, dolomite, marble, etc.; (*b*) Siliceous materials, rich in silica, found in large proportions in sandstone, granite, etc.; (*c*) Argillaceous or clayey materials, found in large proportions in shales, slates, etc. The depth and surface form of these materials, and associated conditions of surface and internal drainage also influence the type of soil development. Such of these physiographic features that are specifically pertinent to the formation and use of Carleton County soils are discussed in this section.*

Carleton County lies within the Eastern Ontario section of the physiographic region of Canada known as the Lowlands of the St. Lawrence. The

*For further regional aspects of the physiography, the reader is referred to Chapman and Putnam's article, "The Physiography of Eastern Ontario," Scientific Agriculture, Vol. 20: 7, March 1940. The surface geology has also been described by W. A. Johnston in "Pleistocene and Recent Deposits in the Vicinity of Ottawa with a Description of the Soils," Geol. Sur. Can. Mem. 101. 1917.

underlying bedrock is chiefly limestone and shale of Paleozoic age, with local outcroppings of Precambrian limestone, gneiss, etc., in the northwest. (See map Figure 3.) Except for local areas, the bedrock is covered with unconsolidated materials, mostly drift. This drift is thin over approximately one quarter of the county. A large proportion of it has been derived from the local bedrock.

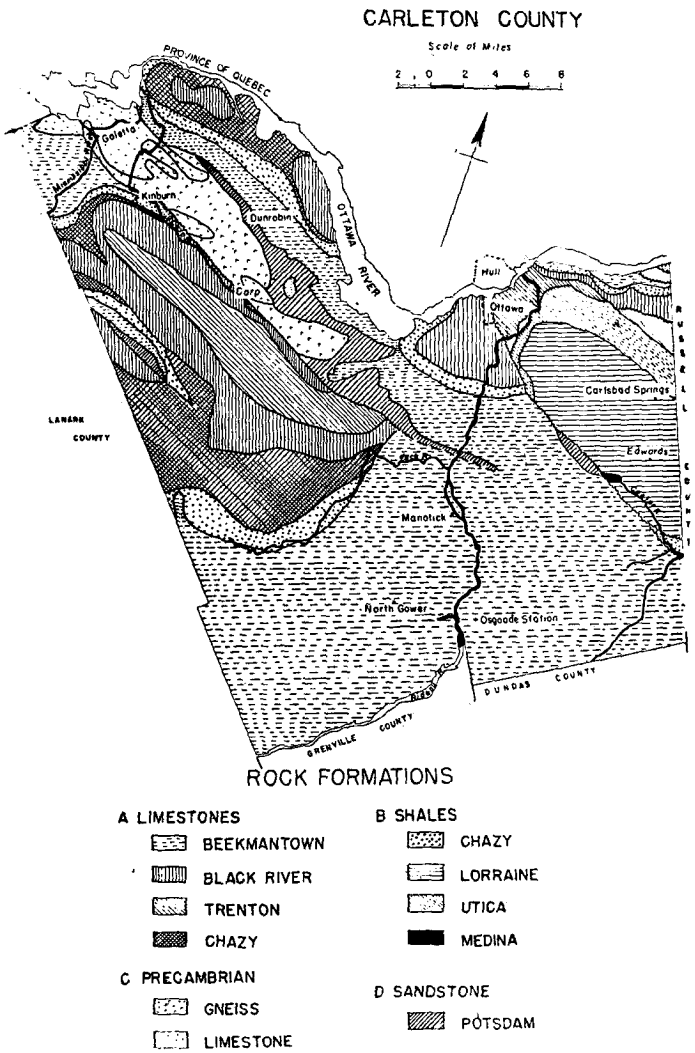


FIG. 3

Most of this drift was laid down either by the ice during the last or Wisconsin glaciation, or by the waters of the Champlain Sea which occupied the depression formed in the wake of the retreating glacier. Comparatively small areas of flood land along the present stream courses, small areas resulting from wind and water erosion, and larger areas of peat and muck are of more

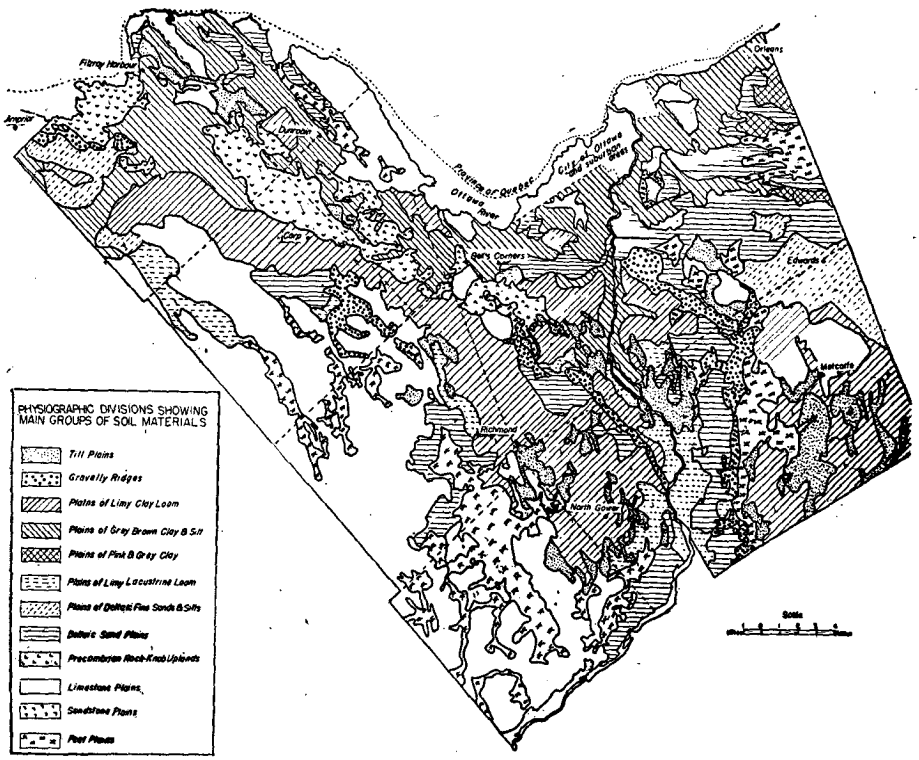


FIG. 4

recent origin. The surface form and internal structure of the geologic materials is largely determined by these agencies of deposition (ice, water, wind, etc.). The surface deposits of Carleton County have been broadly separated into physiographic divisions on the basis of land form and geologic materials. (See map, Figure 4.) The physiographic divisions are as follows:

TABLE 1

PHYSIOGRAPHIC DIVISIONS OF CARLETON COUNTY

1. Till Plains.
   - (a) Limestone till plains.
   - (b) Low-lime granitic till plains.
   - (c) Shaley till plains.

   (The till plains have not been differentiated on the map.)
2. Gravelly Ridges.
3. Plains of Water-laid Sediments.
   - (a) Plains of limy grey-brown clay loam.
   - (b) Plains of grey-brown clays and silts, low in lime.
   - (c) Plains of pink and grey clay, low in lime.
   - (d) Plains of limy loam.
   - (e) Plains of deltaic fine sands and silts.
   - (f) Deltaic sand plains.
4. Rocky Plains.
   - (a) Precambrian rock-knob uplands.
   - (b) Limestone plains.
   - (c) Sandstone plains.
   - (d) Shale plains (too small to indicate on small map).
5. Peat Plains.

1. Till Plains

The till plains are areas where the melting ice has left deposits of considerable depth which have not been subsequently modified to any appreciable degree by the Champlain Sea or other waters. Till deposits are characterized by a lack of sorting. Stones, ranging from very fine grit to large boulders, are scattered irregularly throughout a matrix of sand, silt and clay in varying proportions.

The tills of Carleton County are subdivided into three types on the basis of the dominant rock constituents. The common type throughout most of the county is a loamy limestone till. In the northwest there are small areas of till derived chiefly from granitic rocks with a low content of limestone materials which weather very slowly. Southeast of the city of Ottawa there are local areas of shaley clay till. The two minor till areas have not been differentiated on the map of physiographic divisions.

The topography of the till plains may be broadly described as undulating to slightly rolling. There is frequently, however, a characteristic topography associated with each type of till. The loamy limestone till in North Gower Township and adjoining areas frequently occurs as long oval ridges known as drumlins. Areas which are not drumlinized are usually ridged. The granitic till in the northwest is gently rolling with a drumlinoid form. The heavy shaley till on the other hand is comparatively flat.

(*a*) Limestone Till Plains

The limestone till of Carleton County is derived largely from Beekmantown dolomite, whose composition ranges from a sandy magnesian limestone to a limy sandstone. There are local areas where Trenton, Black River, or Chazy Limestones are dominant. In addition to these limestone materials, there is frequently a fair sprinkling of shale and Precambrian rocks.

This till consists largely of unassorted loamy or sandy loam materials intermixed in a coarse skeleton of grit, stones and boulders. The loamy materials are moderately compact, while the sandy loam and stonier materials are more pervious.

Some of the till areas were, however, modified by the marine waters which covered them. The crowns of the drumlins have been changed in varying degrees through the removal of the finer particles. In extreme cases the upper materials are no longer till, but are similar to those which compose the gravelly beaches and boulder pavements. In the southeast of Osgoode township, the till is smoother and is frequently covered by a shallow deposit of water-laid clay. There are other areas where the limestone till has received a surface deposit of sandy loam apparently of glacio-fluvial origin, and which has been reworked by marine waters.

(*b*) Low-lime Granitic Till Plains

In the northwest of the county near Fitzroy Harbour there are several small areas of till derived largely from acidic Precambrian materials with a small, though significant, proportion of limy materials. These limy materials are chiefly of Precambrian origin and are in a form which weathers slowly. The geologic structure is somewhat similar to the limestone till, although usually not as compact as in the loamier areas.

(*c*) SHALEY TILL PLAINS

These are local areas of till comprised of materials not far removed from the outcrops of Utica and Lorraine shale which occur southeast of Ottawa. This till differs from the two described above in being heavier and more compact, with fewer and smaller stones and practically no boulders. Free lime, as indicated by the effervescence of dilute acid, occurs in these materials although they form an acid soil upon weathering.

2. Gravelly Ridges and Plains

The areas indicated on the map as gravelly ridges are comprised of coarsely stratified gravels and sands which were laid down by streams associated with the melting ice. Others are beach and bar deposits formed by the receding waters of Lake Champlain. In some cases the beach deposits are superimposed on those from glacial streams. Some of the unassorted till released from the melting glacier was picked up by these streams. The stones were rounded to varying degrees and the materials were roughly sorted according to particle size. There are, however, within the framework of these roughly stratified sands and gravels, local deposits of till which are often quite bouldery and little modified by stream action. The sands and gravels were deposited either as elongated ridges (eskers), "bunched up" (kames) or as fan-shaped outwash areas. These are known collectively as glacio-fluvial deposits.

Most of these deposits in Carleton County have been modified subsequently by marine waters. The upper portion of the ridges contains a much greater proportion of coarse gravel, cobbles and boulders than the underlying sands and gravels, suggesting that the waves have removed most of the upper fine glacio-fluvial materials and left the coarser gravel and boulders to form a beach or boulder pavement. Because of this capping of the glacio-fluvial material with beaches, etc., it did not seem advisable to separate this type of gravel from those of the beaches developed on other types of materials.

There are several long trains of these modified deposits in the county. One runs from Reid's Mills in the south of the county through West Osgoode and Greely to the Bowesville area. Another becomes prominent south of Kars, running through that village northward to near Fallowfield. Still another, containing somewhat coarser materials, passes through Stittsville to the neighbourhood of Carp Village. Intermittent deposits of fine sand and gravel from Mohr's Corners to Arnprior indicate a similar train. Broad, sandy areas in the southern part of North Gower would suggest kame deposits modified by the planing action of the waves.

Beaches and bars were formed during each stage in the recession of the marine sea whenever a ridge of bedrock or of drift was exposed to the action of its waves. On many slopes a number of strands at different levels are found. Peculiar beach deposits occur where the waves have worn the limestone ridges until large angular fragments of limestone (shingle) have been loosened and roughly sorted to form undulating crested ridges. Similar beaches were formed on local areas of sandstone and shale. Many of these beach deposits occupy areas too small to be indicated on the map. Such are particularly common on the ridges of limestone till in the south of the county.

3. Plains of Water-Laid Sediments

Large areas within the county are covered by water-laid materials deposited in salty or slightly brackish waters. At the time of glaciation the region was depressed below sea level. As the front of the ice-sheet receded northward, ocean waters followed in its wake, coming up the Hudson and Richelieu valleys and covering most of the lowland areas of the St. Lawrence and Ottawa valleys. This arm of the sea is known as Gilbert Gulf or Champlain Sea. When the glacier receded farther afield, the land gradually rose to its present level, causing a general recession of the marine waters. It was necessary then for streams to extend their courses seaward by eroding channels in the emerging marine deposits. One of these streams, carrying the overflow of glacial waters from northern Ontario and Quebec, flowed in the same general course as the present Ottawa River, and may be conveniently termed the Pre-Ottawa. This stream emptied into the Champlain Sea at a succession of points during its recession. Owing to the continued shifting of the marine waters, the materials which they deposited were by no means uniform.

The internal structure of these marine deposits ranges from coarse stratified gravel and sand to layers of heavy clay which appear to be without structure (massive). The coarse sands were usually deposited in fan-shaped areas where the waters of the inflowing streams were slowed up as they reached the sea. The finer sands and silts were washed further and were deposited in the deeper marine waters to form a concentric ring around the coarser outwash. The clay particles remained longer in suspension and were finally deposited in the deeper waters farther away from the mouths of the streams. During the gradual recession of the sea, much material was removed from the tops of the till and gravel ridges as soon as they were exposed, and this clay, silt and sand was mixed with the clay materials settling from the marine water.

These sediments are likewise variable in chemical composition, reflecting that they have been derived from different rocks. The materials "washed in" from local ridges have the same general characteristics as those from which they were removed. However, these were sorted to varying degrees and mixed with the materials brought in by the streams. The Pre-Ottawa and other streams flowing in from the north brought siliceous and argillaceous materials with a very low limestone content. Those which are siliceous in character are derived, no doubt, from the granitic Precambrian rocks. The argillaceous or clayey materials could have come from the same rocks had they been subjected to weathering for a sufficient length of time. It is more probable, however, that these clayey materials originated from Paleozoic shales, which the glaciers scoured from the Hudson Bay Basin. In order to indicate the variation within the marine deposits, they have been separated into seven physiographic divisions. The marine beaches and boulder pavements have been included in the discussion of the glacio-fluvial gravel ridges and modified till areas. The remaining six divisions will be briefly outlined in the following paragraphs.

(*a*) Plains of Limy Grey-Brown Clays

The materials forming these plains were deposited in Lake Champlain when its waters covered the underlying till and bedrock. The majority of

these materials were laid down when the water was comparatively deep, but as the water gradually became shallower there was an increasing amount of material washed off the adjoining ridges.

Consequently, while the lower sections are commonly layered, or varved, they contain considerable quantities of grit not larger than peas. Toward the surface, the amount of grit and sand increases and the evidence of layering is not so distinct. The structure of these clay loams is therefore less massive and compact than many of the other heavy materials. The unweathered materials effervesce freely with dilute acid, particularly where the content of grit is high. There are also areas in which the unweathered materials contain a comparatively high percentage of limy shells.

The topography of the limy clay plain is generally quite smooth. In the Carp Valley it is gently sloping. It is almost level in a broad area north of Richmond. Farther south where it is studded with numerous "islands" of till it is either flat or depressional.

(*b*) Plains of Grey-Brown Clays and Silts, Low in Lime

The materials which constitute these plains were probably deposited in the estuarian waters or in the channels of the Pre-Ottawa and are chiefly clays and silts which the latter had carried down from the north. That they are now exposed would indicate that either they were not covered by the deltaic sands or alluvial* silts, or that these had been subsequently eroded by the large stream. The clays are heavy and waxy in character and contain little lime. There are other associated areas in which shallow deposits of deltaic sands and alluvial silts have covered the underlying heavy clays which appear at the surface in spots only. In general the sand spots are more common toward the lower section of the plain and fairly deep silty deposits are commoner in the northern part of the county.

This plain consists of a large number of flattish areas so broken as to present an undulating aspect to the general relief. The flooding and channelling of the Pre-Ottawa River have resulted in many steep bluffs and undulating ridges of sand and silt. The difference in level between this plain and parts of the Ottawa and Rideau Rivers has resulted in gullying by even the smallest streams.

While it is generally true that the clay deposits are deep (at least 100 feet), there are areas in the northern section where there is but a scant covering of silt and clay over the bedrock. Where the rock is of the knobby Precambrian type, the topography is undulating to rolling. Where the smoother limestone type constitutes the upper rock surface, the clay deposits are comparatively level.

(*c*) Plains of Pink and Grey Clay Low in Lime

The geological materials forming these plains were probably laid down when the marine waters had narrowed down to a mere estuary confined within a few miles of the present Ottawa River. While in some places the unweathered materials effervesce with dilute hydrochloric acid, they are generally very low in lime. There are comparatively thick layers of pink (or reddish grey) clay

*The term alluvial is used in this report to designate the deposits of the Pre-Ottawa River rather than the flood plains of the present Ottawa.

of an extremely heavy, waxy nature alternating with layers of grey-brown materials somewhat more silty in texture. In local areas, fragments of shale are found imbedded in these layers. Where these fragments occur, the materials contain a higher percentage of lime. They do not make the structure more pervious. It would appear that some of the red clay may have been derived from the local shale, but it is probable that most of it has been brought in from the north by the Pre-Ottawa and other streams which have removed any limy material which may have been previously associated with it.

There are local areas where the surface deposits have been modified at a later stage when the Pre-Ottawa, which then replaced the estuary, was channelling its course toward the ever-receding margin of the sea. In places this stream has deposited sandy materials which are occasionally intermixed with the clay to form a loam. In other places the stream has cut deep channels in the clay, leaving prominent bluffs. The topography is therefore somewhat variable. In general, the relief consists of smooth clay areas at various levels separated by sloping clay bluffs and broken by undulating deposits of sand, often of shallow depths over the clay.

(*d*) Limy Loam Plains

In large part the loam plains are areas where there has been sufficient sand and silt derived from local sources to mix with the marine clay coming out of suspension to form a loam. In a few places there appears to be a local combination of deltaic sand and marine clays. In general they are associated with plains of limestone till or bedrock. The topography is gently undulating.

The structure of these loamy deposits vary. There are a few local areas where there is a uniform deposition of stone-free loam at least four feet deep. More generally, however, the surface deposits are lighter (a sandy loam or sand) and are underlain at shallow depths by clay commonly of the limy clay loam type.

(*e*) Plains of Deltaic Fine Sands and Silts

These plains are parts of deltas formed by materials poured into the Champlain Sea by the Pre-Ottawa and other streams. The coarser materials were deposited first and the finer materials were carried farther out.

These are uniform deposits of stone-free materials varying from a sandy loam to a silt. Laid down in layers differing little in texture, these deposits are uniform for some depth. Only locally are there strata of heavy clay close to the surface. In common with the other materials brought in by the Pre-Ottawa these are low in lime. The topography is smooth, with slight undulations due to erosion near the stream courses.

(*f*) The Deltaic Sand Plains

The deltaic sand plains were formed where the Pre-Ottawa and other streams emptied into the sea. The river, lengthening as the sea lowered, cut down one delta to build up another at a lower level. Such a delta was formed and partially destroyed in the vicinity of the city of Ottawa. The outer perimeter of coarse sands extends from Bell's Corners eastward through Carlsbad into Russell County. The area of these deposits indicates that the

present Ottawa River is not nearly as large as its predecessor. When the Champlain Sea again receded the Pre-Ottawa cut a channel through the areas just described. In some places it removed the sand deposits, leaving the clay practically bare. Some of these old channels can be definitely noted in the Hawthorn area and through the Mer Bleue Peat Bog eastward into Russell County. These are flat areas of clay and shallow sand or peat bounded by bluffs fifteen feet or more in height. The upper portions of the bluffs are composed of sand underlain by clay, usually at a greater depth than ten feet. In other places the only trace of delta and channel is a clay plain showing evidence of erosion and covered with numerous sand spots (a condition described as associated with the plains of grey-brown clay).

Most of the sand in the delta area is composed of much-washed Precambrian materials, which has resulted in a very low lime content. A small part is of local origin, but the content of calcareous (limy) and argillaceous (clayey) matter is very low.

The deltaic sands are commonly found on an undulating plain sometimes bounded by the steep slopes of the Pre-Ottawa channel. The materials include gravel and sands of various sizes uniformly layered or stratified. There are also sand areas which have been considerably modified by wind erosion.

4. Rocky Plains

On three of the physiographic divisions there is but a shallow covering of drift over the bedrock, namely: (*a*) the *Precambrian Rock-knob Uplands*, (*b*) the *Limestone Plains* and (*c*) the *Sandstone Plains*. Areas of shallow shale soils also occur, but these were considered too small to indicate on the generalized map. The period of weathering has been so short since glacial times, that it is doubtful if much of the shallow drift has been weathered directly from the underlying bedrock without having first been broken up and shifted around by water, wind or ice. These shallow deposits are chiefly: (*a*) stony materials resulting from the melting of a lightly loaded glacier, (*b*) sandy and gravelly materials formed by glacial streams or wave action, and (*c*) clays and loams laid down in deeper waters. Owing to the nearness of bedrock, most of these deposits contain stones regardless of their mode of deposition.

5. Peat Plains

The materials comprising the surface deposits of the peat plains are largely of organic origin, being the humified remains of trees, herbs or mosses. These materials differ not only in plant origin but also in state of decomposition which is often closely associated with the type of decaying plants. The organic deposits in Carleton may be divided into two classes, peats and mucks. The peats consist of moss and tree materials which are little decomposed and usually support a moss vegetation. The mucks are in a more advanced state of decomposition and support a tree or a herb vegetation, the latter consisting chiefly of sedges. The herbaceous materials decompose most rapidly. Conditions favourable to extensive tree growth are also favourable to fairly rapid decomposition so that trees and sedges are usually associated with muck, and mosses and scrub with peat. There are few bogs which can be classified

accurately as one or the other. However, those bogs situated in depressions of the more acid sands and clay materials such as the Mer Bleue have characteristics which are dominantly of the peat bog type. The numerous bogs throughout the limier areas toward the south of the county are generally mucks. However, the centre of the larger of these bogs is frequently of a peaty nature. Both peats and mucks are indicated on the map as peat plains.

Relief

The relief of the county may be described in brief as an undulating plain of clay and till materials with local outcrops of bedrock. The topography has been discussed under the physiographic regions. With few exceptions the altitude ranges from 200 to 400 feet above sea level. A comparatively narrow plain along the Ottawa River between Ottawa and Orleans lies between 200 and 150 feet. The normal level of the river at these points is approximately 130 feet. Hills and ridges rising sometimes as high as seventy-five feet above the general level of the surrounding plain are locally common in till areas where the bedrock is deeply buried. In the vicinity of Ottawa, and in many other areas, there are steep rocky slopes presenting on the one side a scarp-like face, exceeding, in some cases, 100 feet in height and sloping gently away in the other direction. The highest point in the county would appear to be one of these limestone uplands in Huntley Township where the elevation is above 525 feet. In strong contrast to these smooth rocky uplands is the irregular hummocky surface of the "rock-knobs" which characterize the topography of the Precambrian uplands. A spur of this formation crosses the Ottawa River from Quebec and occupies a long narrow ridge in the northwestern part of the county. In elevation, however, it does not reach within a hundred feet of the heights attained by the limestone ridges of the southwest.

The county is drained exclusively by the Ottawa River and its tributaries. The drainage pattern presents a comparatively youthful appearance with numerous parallel tributaries. Most of the county lies within the basin of four of these tributaries. The Rideau River which forms part of the Rideau Canal system drains the central portion. The southeast is served by the Castor, a tributary of the South Nation River. The western portion is drained by the Carp and the Mississippi Rivers. The level nature of the plain is indicated by the fact that the Carp and the Jock (a tributary of the Rideau) have a common source and also that a comparatively low ridge (the Bowesville esker) does, in the main, form the height of land between the Rideau and South Nation Rivers.

In general, there is sufficient slope to facilitate fair regional drainage. There are however, a number of bog areas formed not only in the depressions in the clay and stony till plains but also in shallow rock depressions. The largest bog, Mer Bleue, lies a few miles east of the city of Ottawa.

Climate

Carleton County has a cool humid climate, tending to be colder than that commonly prevailing in the lowlands region of Ontario, adjoining the Great Lakes and the St. Lawrence River. Putnam and Chapman include the county in their Eastern Ontario Region. The reader is referred to their paper "The

Climate of Southern Ontario"* for a general description of this region, and its relation to the rest of Southern Ontario.

The only meteorological stations located within the county are near Ottawa, a "long term" one having been operated at the Experimental Farm since 1890. Two other stations in adjoining counties, the data of which may be of some value to an analysis of the county's climate are Almonte, a short term station a few miles from the western boundary, and Morrisburg, situated some thirty miles south of the southern border.

Since the climate of an area is reflected in the development of its natural vegetation and soils, it is worth while to compare the climate of the area under study with that of stations representing other vegetation zones. Carleton County lies toward the northern extremity of the zone of southern hardwoods and grey-brown podsolic soils which is common to the greater part of agricultural Southern Ontario. For the purpose of comparison, data from this and two other zones are presented; Brantford representing the southern hardwood zone, Huntsville the transitional zone between hardwoods and conifers, and Kapuskasing the northern coniferous region. Climatic data for Guelph are also given in order to correlate the climatic factor with the crop yields available at the Ontario Agricultural College.

*Putnam, D. F., and Chapman, L. J.—The Climate of Southern Ontario. Sc. Ag. 18; 8 April 1938.

TABLE 2

MEAN MONTHLY TEMPERATURE FOR OTTAWA AND OTHER SELECTED POINTS IN ONTARIO

Temperature in Degrees Fahrenheit

	Period of Record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Ottawa	52	11.8	12.7	24.7	41.4	54.9	64.6	68.9	66.3	58.5	46.2	32.4	17.3	41.6
Almonte	11	11.7	12.6	26.0	41.9	54.3	63.3	68.9	64.6	56.9	46.9	32.1	17.8	41.4
Morrisburg	24	15.6	15.2	26.8	40.0	52.8	62.4	67.2	64.9	62.7	46.6	34.3	19.9	42.4
Huntsville	30	13	12	22	38	52	61	65	63	56	44	31	18	40
Kapuskasing	19	−2	2	14	31	46	57	62	60	51	39	21	6	32
Brantford	62	21 6	19.5	30.5	43.3	55.4	64.9	69.9	67.3	60.7	48.2	36.9	25.7	45.3
Guelph	55	20	19	28	42	53	63	68	66	59	47	36	24	44

TABLE 3

TEMPERATURE RECORD AT THE CENTRAL EXPERIMENTAL FARM, OTTAWA, ONT.

For the Period 1890 to 1942 Inclusive

Months	Mean Monthly Temperature	Highest Mean Monthly Temperature	Lowest Mean Monthly Temperature
January	11.8	23.8	1.9
February	12.7	20.9	−2.7
March	24.7	33.7	17.4
April	41.4	49.7	33.2
May	54.9	63.0	48.2
June	64.6	71.1	59.7
July	68.9	76.1	64.4
August	66.3	70.7	61.6
September	58.5	63.6	53.3
October	46.2	53.7	38.9
November	32.4	38.6	20.4
December	17.3	28.6	5.1
Mean Annual	41.6	44.8	38.6

The mean annual temperature at Ottawa is 41.6°, as compared with 45.3° at Brantford, 32.0° at Kapuskasing, and 40.0° at Huntsville. The mean annual varies from 38.6° to 44.8°. January and February are about equally as cold at Ottawa, the mean monthly lows being lowest in February, though the all-round mean for January was lower than that of February. The lowest monthly mean for Ottawa (−2.7° for February) is much below the 10.9°F. mean for the same month recorded for Brantford.

The winter mean temperature (December, January, February) of 14°F. is comparatively lower than that for south-central or southwestern Ontario, and about the same as the Precambrian Uplands to the west. The mean spring temperature is approximately 40°F. This is slightly in advance of the Huntsville district, but still under the 43° average for Brantford. The summer average of 66.6°F. is not far from that which prevails in the rest of Southern Ontario. The autumn mean is 45.7°, which is similar to that of Guelph. The highest temperature on record is 100°, while the extreme low is −38°, giving a range of 138°F. The mean average daily range is approximately 19°F. The average frost-free period is 146 days (May 7 to September 30). The date of the latest spring frost is May 29, and that of earliest fall frost is September 10.

In general the temperatures of Carleton County, while lower than the

rest of agricultural Southern Ontario, are more closely similar to those areas than to most of Northern Ontario. It has many features in common with the area around Huntsville, although the spring temperatures are somewhat more favourable. However, there are a number of features which distinguish it from the remainder of Southern Ontario. The greater distribution of spruce suggests a climatic or soil difference or both. It would appear that the temperature, particularly low winter temperature, is responsible for this difference in natural vegetation. Too, there is a marked difference in the cultivated crops adapted to this climate. Putnam and Chapman point out that the low winter temperature is largely responsible for the small acreage of winter wheat grown in the county as the coldward limit of most commonly cultivated varieties correspond to the winter isotherm of 18° F. Winter hardy varieties however are being developed and tested at the Central Experimental Farm, Ottawa. It has also been suggested that the production of winter wheat is affected by the variable spring weather. Statistics are not available to prove this point.

Owing to the severity of the winters the common varieties of apples, pears and cherries grown commercially in Ontario's fruit belt are not recommended for this area. Some hardy varieties developed at the Central Experimental Farm are the only ones recommended. While there appears to be a number of reasons for winter killing, it is believed that few of the commercial varieties of trees can survive a temperature of −20°F. or lower, particularly when it continues over a considerable period. W. T. Macoun, Dominion Horticulturist in 1918 presented climatic data* for the winters of 1903–4 and of 1917–18, in which severe losses by winter killing were experienced at the Central Experimental Farm. Long cold spells, with temperatures below −20°F., were common during these periods.

The average length of growing season (i.e. temperatures above 42°F.) is approximately 190 days. The average date of seeding spring grain is April 27, the earliest being April 10 and latest May 27.

TABLE 4

MEAN MONTHLY RAINFALL IN INCHES FOR OTTAWA AND OTHER SELECTED POINTS IN ONTARIO

	Period of Record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Ottawa	52	2.98	2.40	2.65	2.32	2.74	3.39	3.67	3.00	2.94	2.68	2.63	2.84	34.24
Almonte	11	2.72	1.89	2.62	3.00	2.95	3.54	2.81	3.11	3.11	3.39	2.64	2.38	33.16
Morrisburg	24	3.69	2.97	3.09	3.28	3.22	3.20	3.12	3.34	2.83	3.42	3.35	3.09	38.60
Huntsville	30	3.09	2.45	2.78	2.09	2.85	3.69	2.96	2.70	3.84	3.44	3.29	3.28	36.46
Kapuskasing	19	2.00	1.06	1.56	1.82	2.12	2.33	3.43	2.94	3.54	2.50	2.39	1.90	27.59
Brantford	62	2.61	2.12	2.16	2.54	2.90	2.65	3.05	2.93	2.63	3.47	2.40	2.24	30.70
Guelph	55	2.35	1.79	1.88	2.30	2.80	2.89	3.24	2.87	2.67	2.39	2.48	1.99	29.65

*Macoun, M. T., 1918. Winter Injury in Canada, Am. Soc. Hort. Sc. Proc. 15, 13–17.

TABLE 5

RAINFALL RECORDS AT THE CENTRAL EXPERIMENTAL FARM, OTTAWA, ONT.

For the Period 1890 to 1942 Inclusive

Months	Precipitation (Inches)			Days with .01" or more of Rain
	Mean	Highest	Lowest	
January	2.98	5.45	1.18	12
February	2.40	4.48	.80	10
March	2.65	5.60	.67	11
April	2.32	4.37	.75	10
May	2.74	6.89	.24	12
June	3.39	7.30	.82	11.5
July	3.67	9.85	1.40	10
August	3.00	9.05	.38	10
September	2.94	6.12	.44	11
October	2.68	5.89	.25	11
November	2.63	7.76	.73	11
December	2.84	4.81	1.03	11.5
Mean Annual...	34.24	42.94	24.39	

The mean annual precipitation at Ottawa is 34.24 inches. On the average ninety inches of snow falls annually. The summer rainfall is uniform, with very little tendency to extremes. (See Tables 3, 4 and 5.) The rainfall for the period May to September (the approximate growing season) is 15.74 inches, while an average of 10.06 falls during June, July and August. It would seem that the amount and distribution of rainfall is satisfactory for general farm crops. Further, the success of general farming depends on the amount and distribution of rainfall during grain and hay harvest. It is not merely a matter of total number of dry days during this period. Much depends on whether these are consecutive. The period of dryness must be sufficiently long to allow for harvesting and field curing of the crops. The rainfall records for Ottawa for thirty-nine years have been analyzed and the results summarized in the Report of the Dominion Field Husbandman for the year 1928. Considering four consecutive dry days necessary for the curing of clover during July, it was found that there were an average of 3.2 such groups during that month.

In brief, the climate of Ottawa is characterized by very cold snowy winters and warm summers. There is little likelihood of drought, and yet the weather is generally favourable during the harvesting seasons. The cold winters make it generally unsuitable for all but the hardiest varieties of winter wheat and tree fruits. The comparatively short growing season also limits the range of tender crops grown.

TABLE 6

FREQUENCY OF WET AND DRY MONTHS GROWING PERIOD—MAY TO SEPTEMBER

Central Experimental Farm, Ottawa

Classification	May Aver. 2.74"	June Aver. 3.41"	July Aver. 3.70"	Aug. Aver. 3.01"	Sept. Aver. 2.94"
	NUMBER OF MONTHS OCCURRING IN 52 YEARS (1890–1941)				
Extremely Dry					
Less than 25% of average (.01 to .68)	4	1	0	2	1
Very Dry					
25% to 50% of average (.69 to 1.36)	2	4	5	8	4
Moderately Dry					
50% to 75% of average (1.37 to 2.04)	11	11	8	6	10
Approximately Average					
25% below to 25% above average (2.05 to 3.41)	19	23	27	22	22
Moderately Wet					
25% to 50% above average (3.42 to 4.09)	7	6	8	8	6
Very Wet					
50% to 75% above average (4.10 to 4.77)	4	3	2	4	5
Extremely Wet					
More than 75% above average (4.78 and above)	5	4	2	2	4

Natural Vegetation

The natural vegetation of Carleton County is, in the main, a mixed forest of hardwoods and conifers. Halliday includes the county in the Upper St. Lawrence section of the Great Lakes—St. Lawrence Forest Region.* Lying toward the northern extremity of this section, the area may be considered a transition belt between the deciduous hardwood and mixed forest regions. This is largely the result of the transitional nature of the climate. Local differences in the site may modify the effect of climate so that in one locality the trend will be chiefly toward hardwoods; in another toward conifers. Since each of these types differ to a marked degree in their effect upon soil formation, the vegetation has been broadly placed into two divisions according to their associations.

The group of associations common to much of Southern Ontario consists largely of hardwood species, with a fair sprinkling of conifers. In the county they are found on limy soil materials except where these are extremely poorly drained. Local differences, particularly in moisture relationships within the soil materials, result in different patterns known as associations. There are five main associations in which hardwoods predominate, four of which are common to Southern Ontario in general. The general locations of these are shown on the map (Figure 5). *White and Red Cedar and Sugar Maple* predominate on the shallow limestone plains and more locally on steep slopes of the limestone till. *Sugar maple, beech and hemlock* are found on the deeper well-drained drift over limestone and shaley bedrock and on the limestone till areas. On the heavier, less perfectly drained areas, are found an association of *maple, elm, oak and pine.* On the poorly drained limy areas, *elm, ash and soft maple* are common.

*Halliday, W. E. D.—A Forest Classification for Canada. Bul. 89. Forest Service, Dept. of Mines and Resources, Ottawa.

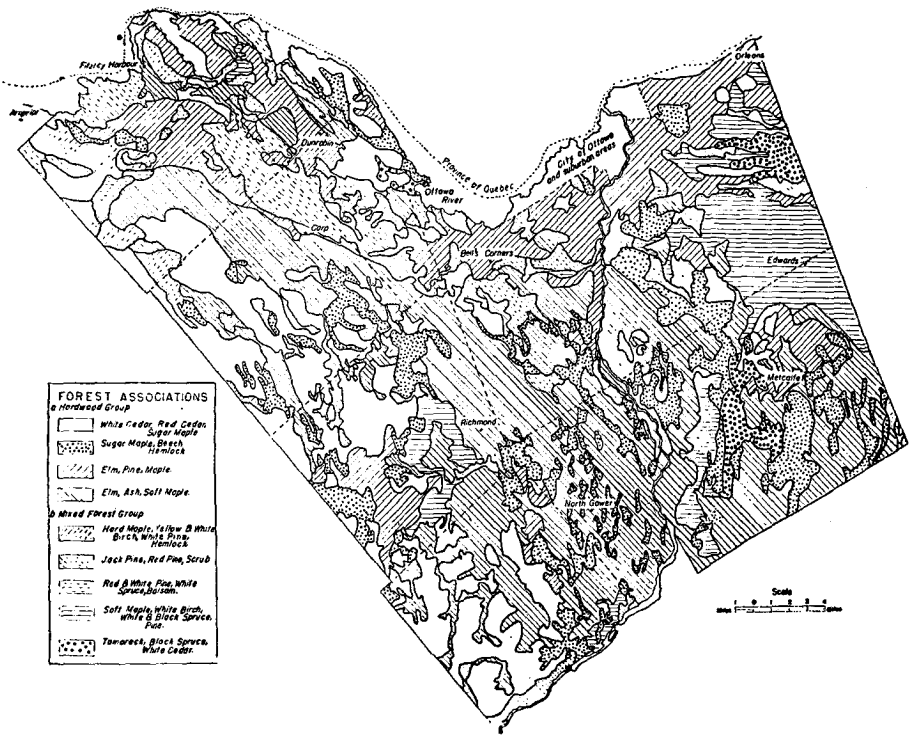


FIG. 5

The second group of associations are found commonly throughout the mixed forest belt (Halliday's L 4) which occupies the Precambrian Shield between the Ottawa River and Georgian Bay. These associations are more common in the north of the county but extend southward on the more acid and poorly drained soil materials. Among the five associations within this group only one is predominantly hardwood. This association of *yellow birch, sugar maple, white birch, hemlock and white pine* is placed in this group because of its distribution in the mixed forest belt, rarely occurring in the hardwood forest belt. It is found in the north of Carleton County on sandy morainic and shallow soil materials similar to those on which it occurs throughout much of its range.

Associated with the yellow birch-maple type in the county are four associations dominantly coniferous. *The Jack pine–red pine* associations occupy the dry sandy plains frequently of shallow depth over bedrock. Occasionally they are found on the steep-sloping or eroded clay banks. *Red and white pine, white spruce and balsam fir* are found on the northern acid clays with fair to poor natural drainage. On poorly drained acid materials the common tree species are *white pine, white spruce, white birch, black spruce* with an occasional elm or soft maple. On poorly drained acid materials ranging from sands to clays the common tree species are *white pine, soft maple, white birch, white*

and black spruce. On many of the organic soil areas *tamarack, black and white spruce, white cedar and alder* are common. This coniferous association is common in the mixed and coniferous forest regions, but also extends into the hardwood forest regions in local areas. On deep, acid, peat areas the tree growth is either scrubby or entirely absent.

Age

According to Antevs* the Champlain Sea receded about 13,000 years ago, but the deposits in the Ottawa estuary remained covered for another 4,000 years. Thus the soils of the county have been weathering for 9,000 to 13,000 years. This is about half as long as the time which has elapsed since much of southwestern Ontario was first exposed to weathering. Not only have the forces of weathering been active on the geologic materials for a comparatively short time, but their influence has been lessened in large areas of the county because of the poor internal drainage.

Erosion

Owing to the large areas of comparatively flat, poorly drained land, water erosion has not played a significant role in the formation of the Carleton soils generally. However, where the drainage waters have considerable fall within a short distance, as they frequently do in order to join the water level in the Ottawa and Rideau Rivers, even the smallest freshet erodes a deep gully in the marine plain in a comparatively short time. Accelerated sheet erosion induced by man's failure to maintain a satisfactory vegetative cover on sloping land is now common on the clay plains and to a lesser degree on the till areas in the south. Wind erosion has modified, to an appreciable extent, a number of local areas in the county such as the Uplands, Merivale and Constance Bay areas.

*Antevs, E.—Late Quaternary Upwarpings of Northeastern North America. Journal of Geology, Vol. 47, 1939.

PART III

THE CLASSIFICATION AND DESCRIPTION OF CARLETON COUNTY SOILS

The soils of Carleton County are quite variable. These differences may be summarized in simple terms of texture, drainage, and land use. Approximately one-quarter of the area is dominated by imperfectly drained, heavy soils, fairly well adapted to general farm crops. Intermediate textured soils (loams, and sandy loams over clay) also occupy one-quarter of the area and are fairly well adapted to general farming. One-tenth of the county has light textured soils which, with few exceptions, are not well adapted to general farming. Some of these are as well suited to growing specialized crops (such as potatoes) as any soil in the county. A considerable area is devoted to pasture and forests, the latter being a suitable land use for a large percentage of the sands. Approximately three-tenths is characterized by shallow soils over bedrock which are largely grazing and forest lands. In the remainder of the county (one-tenth), organic soils are dominant.

In order that soil variations may be more thoroughly understood, a systematic soil inventory has been made. This involves a regional classification which indicates the relationship of these soils to the soil groups of the world, and a subdivision of these regional types to show local differences and similarities.

Regional Soil Types

The soils of Carleton County reflect the transitional nature of the climate and of the vegetation under which they have developed. The comparatively low temperatures and the relatively high humidity has resulted in an acid leaching or podsolization process occurring on all the better-drained sites. Owing to the transitional nature of the climate, local variations of soil materials and natural vegetation have been able to bring about differences in the type of leaching with a range as great as that found within three soil zones. Grey-brown podsolic and brown podsolic soils are found on the well-drained loams of the southern and northern sections respectively. Podsols have a wider distribution than either of these but are found only on acid materials more excessively or more imperfectly drained. On the better-drained high-lime materials, such as those found on the shallow limestone plains, there is very little leaching, the main soil-forming process being a mixing of organic and mineral matter. Soil-forming processes on the poorly drained mineral soils differ according to the lime content. On the limier soil materials, the organic matter becomes fairly well mixed with the mineral portion, while on the acid materials the organic and mineral matter do not readily mix, the former accumulating as a surface mat. The subsoils of both are commonly mottled with rusty brown. Peat and muck accumulate on the extremely poorly drained sites.

The grey-brown podsolic soils are found chiefly in the southern portion of the county on well-drained limy materials supporting a maple-beech vegetation. The layers or horizons which reflect the various soil-forming processes under these conditions are shown in the following description of a Grenville loam profile, the major grey-brown podsolic soil occurring in the county.

A_0— Very thin mat of partially decomposed organic matter.

A_1—4″—Dark brown friable loam with few stones; pH 7.0.

A_2—6″—Light brown friable loam containing few stones. Earthworms present. Many small roots were interwoven with the mineral soil; pH 6.5.

B_2—4″—Moderate yellow-brown compact stony loam; a few small roots; pH 6.8.

B_3—4″—Yellow-brown, compact stony loam; few small roots; no carbonates; pH 7.0.

C_1— Yellow-grey stony loam; few small roots; carbonates present; pH 7.8.

The A_0 is thin since most of the organic matter mixes with the underlying mineral matter to form the A_1. The yellow-brown leached layer (A_2), though comparatively thick, does not show the intensity of leaching that is evident in the podsol. The darker layer in which the colloids accumulate (B) is usually fairly compact. This Grenville loam profile is not as deeply weathered as those profiles developed on loamy limestone till in southwestern Ontario. This doubtless reflects the shorter length of time which Eastern Ontario materials have been subjected to weathering. (See also Figure 8.)

The brown podsolic soils are found on local areas in the northern part of the county where a mixed forest of hard maple and pine has been established on a well-drained, loamy, low-lime till. The following description of a Galesburg loam profile will serve as a comparison between the grey-brown podsolic and brown podsolic soils.

A_0—1″ —Mat of partially decomposed leaf litter.

A_1—2″ —Dark grey-brown sandy loam; pH 6.4.

A_2— ¼″ to 1″—Grey leached sandy loam; pH 5.8.

B_2—6″ —Moderately dark yellow-brown sandy loam—little compaction; pH 6.0.

B_3—6″ —Light yellow-brown sandy loam; pH 6.4.

C— Yellow-brown stony loam; carbonate content very low; pH 6.8.

As indicated above, the brown podsolic soils have a fairly definite A_1 horizon, but this is generally more fibrous and less crumby than that commonly found in the grey-brown podsolics. The A_0 horizon is shallow and resembles that of the podsols. The underlying layer, shown as the B horizon, has not the compact structure common to the grey-brown podsolic soil. Neither is the boundary as consistently distinct between the B and the slightly weathered parent materials underlying it. (See also Figure 8.)

The soils which reflect the most intensive leaching (podsols) occur generally throughout the county on coarse low-lime materials. Owing to the open nature of these materials they are excessively drained where the water table is low. They are imperfectly to poorly drained when the water table is closer to the surface. Podsols are found on each of these drainage types. While both

are characterized by a grey leached layer there are certain differences as indicated in the following diagrams showing the two types of podsol profile. The following description of Uplands sand represents the development on the excessively drained low-lime sands.

A_0—1″ —Mat of leaf litter.

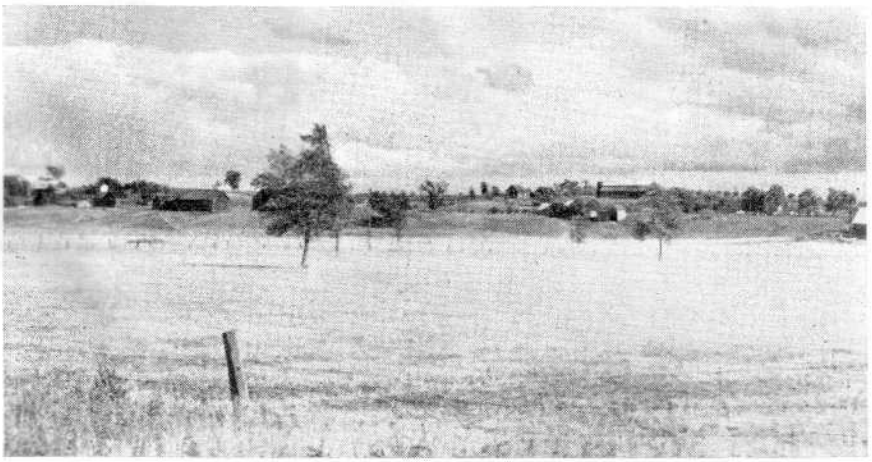
A_1—1″ —Grey-brown loamy sand; pH 5.6.

A_2—1½″ —Ashy-grey leached sand; pH 5.2.

B_2—1″ —Yellow-brown loamy sand; pH 5.0.

B_3—24″ to 48″—Pale yellow-brown sand; pH 5.4.

C— Grey sand and in some cases gravel. Carbonates are commonly absent in sand and low in gravel; pH 6.0.



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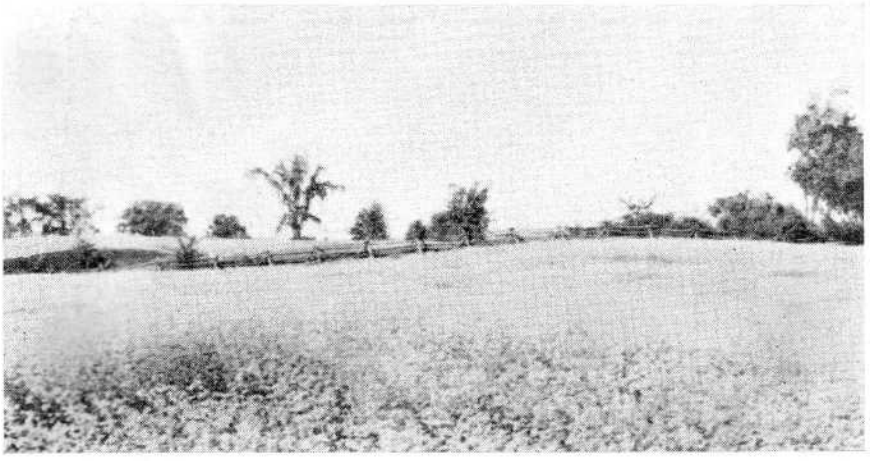
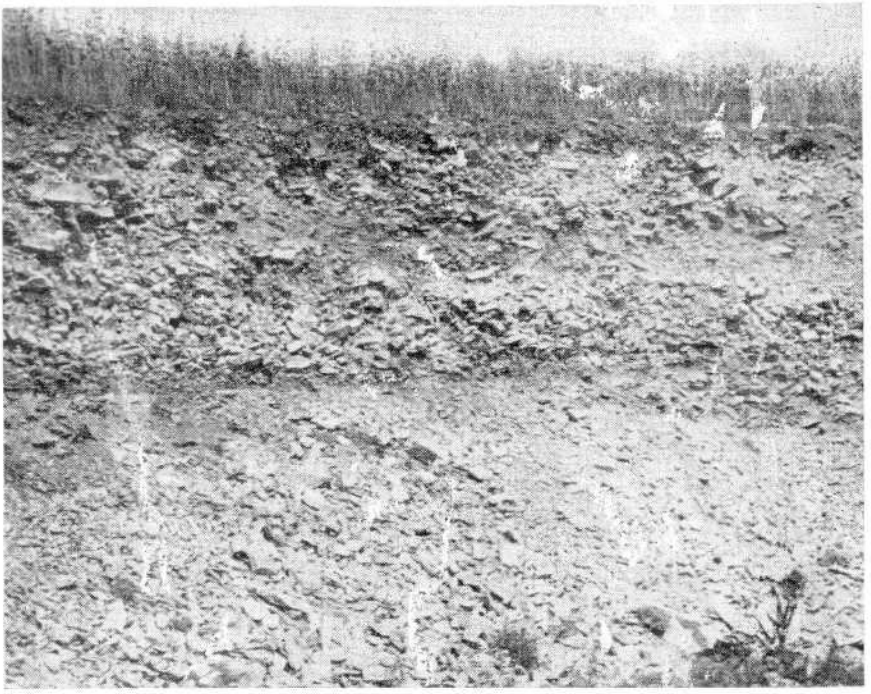


No. 3

FIG. 6. Topographical scenes: (1) Plains of grey-brown clay, low in lime. Clay bluffs channelled by the Pre-Ottawa appear in the background. Mainly Rideau series. (2) Plains of limy grey-brown clay, mainly North Gower series. (3) Ridges of limestone till, mainly Grenville sandy loam.

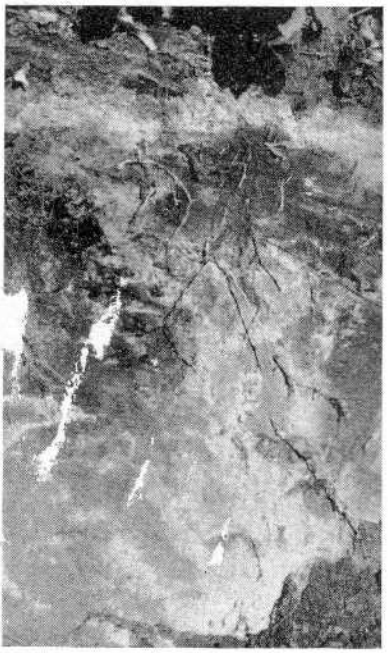
No. 1



No. 3

FIG. 7. Cross section of soil materials: (1) Varved pink and grey clay. Parent material of the Bearbrook series. (2) Bouldery gravel over stratified gravel common to the glacio-fluvial ridges. Parent material of the Kars series. (3) Shingly beach formed from limestone bedrock. Parent material of Farmington shingly, sandy loam.

No. 1



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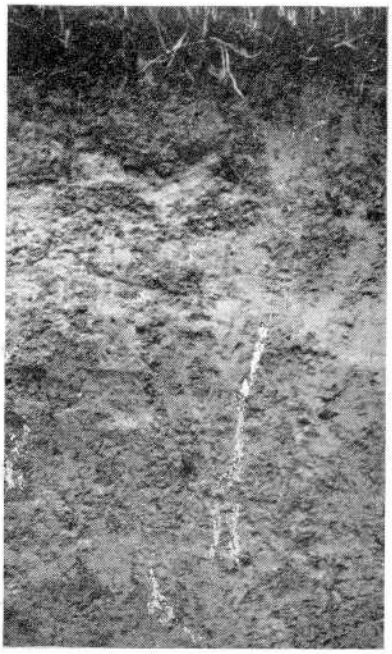

No. 4

FIG. 8. Soil profiles developed under good natural drainage: (1) Grenville loam. (2) Galesburg sandy loam. (3) Farmington loam. (4) Carp clay loam (representing a phase better drained than typical).

No. 1

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No. 3

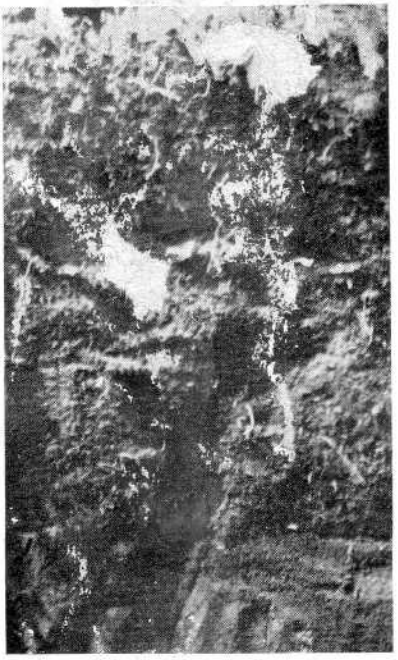

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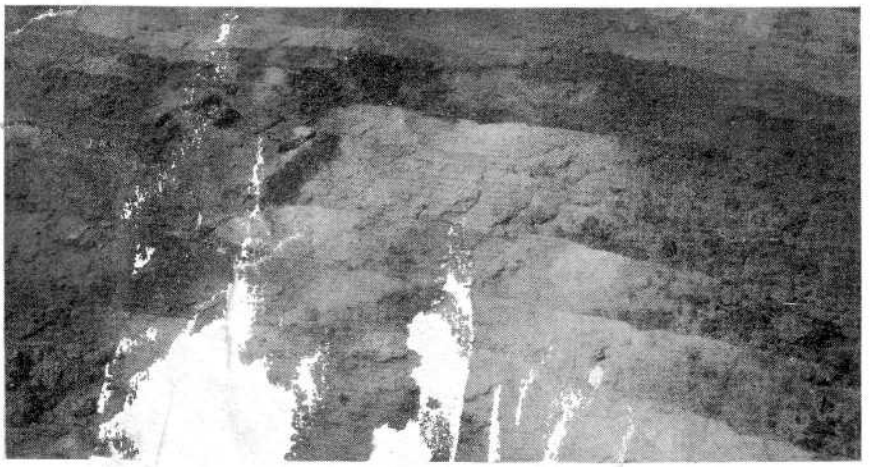
FIG. 9. Soil profile developed under im fect to poor natural drainage: (1) Rideau clay. (2) Castor silt loan (3) Rubicon sand. (4) Peat



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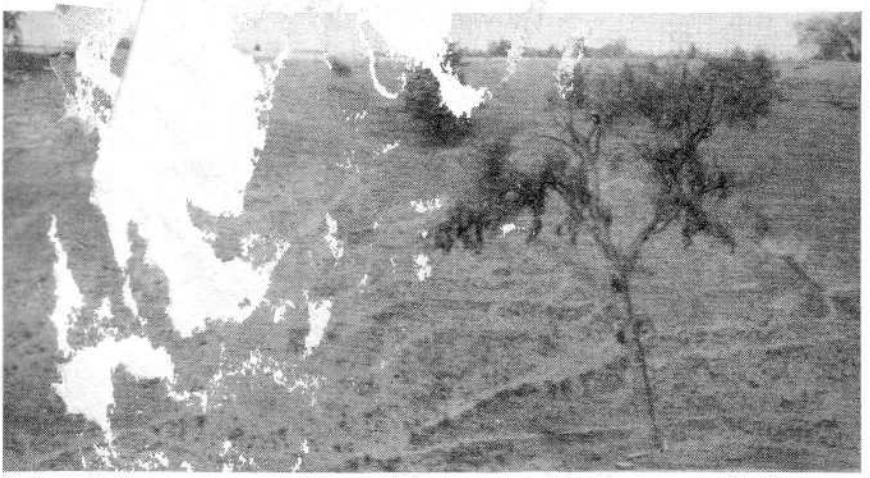

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FIG. 10. Soil conservation mea res: (1) Application of organic matter, lime and mineral fertilizers on the p rer and more acid soils is necessary. This freshly broken field of Rubicon sand shows the grey acid leached layer and iron hardpan turned up by the plo (2) Control of water erosion is urgent on this eroded phase of the Rideau clay. (3) Planned drainage improves the production of the Castor silt loam.

No. 1

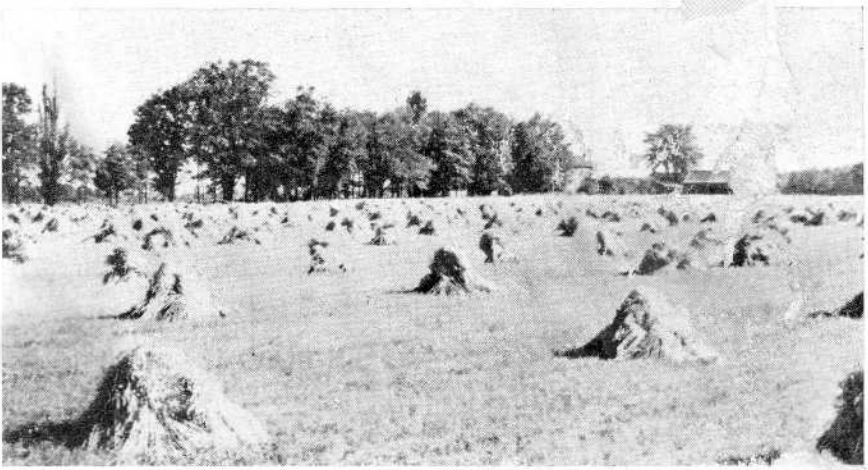

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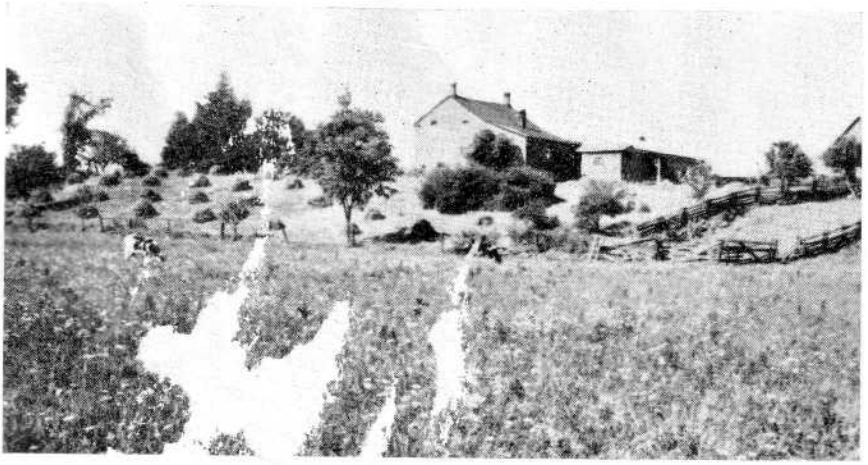
FIG. 11. Agriculture on the limy, water-laid plains under improved drainage: (1) Carp clay loam. (2) Osgoode loam. (3) North Gower clay loam.



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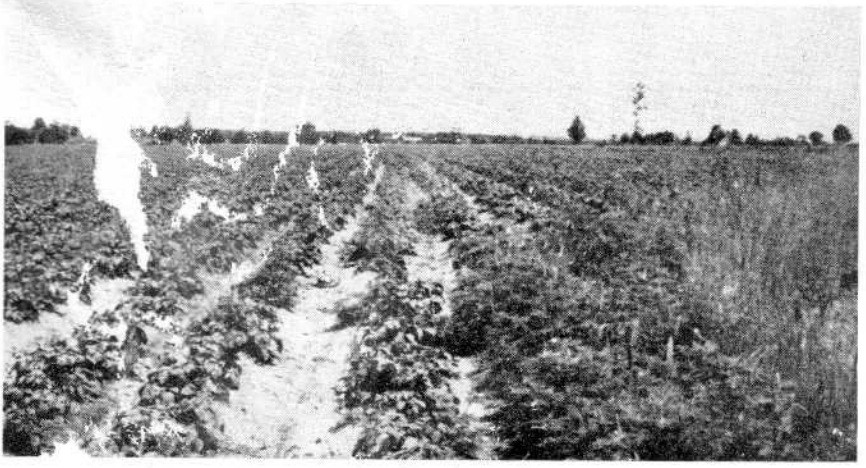

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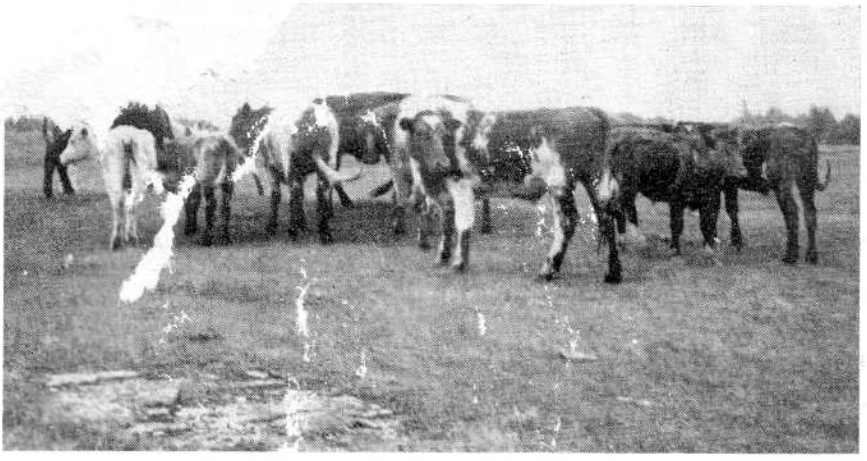
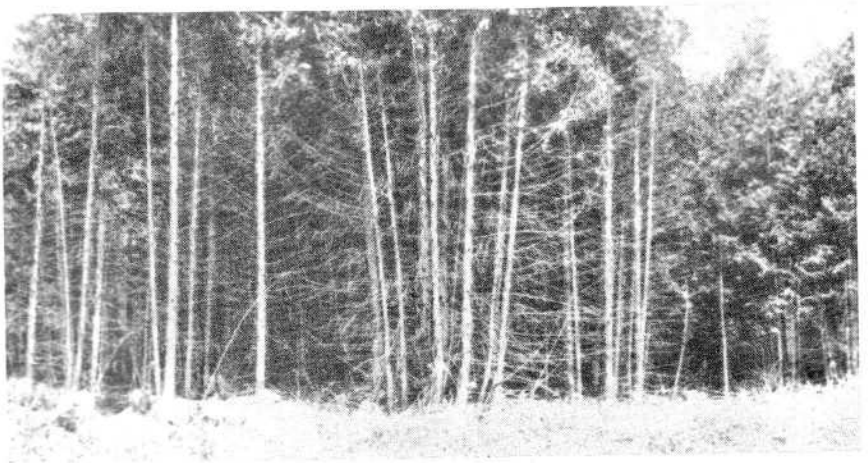


No. 3

Fig. 12. Agriculture on the well-drained, stony soils: (1) Grenville loam—general farming. (2) Kars gravelly, sandy loam—specialized farming. (3) Farmington—grazing.



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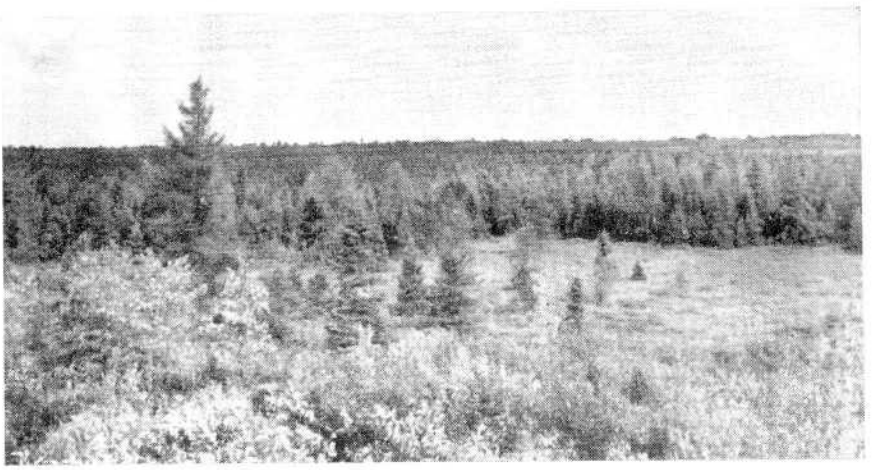


No. 3

FIG. 13. Utilization of rocky and peat lands of low agricultural potential: (1) A "crop" of cedar fence posts on drier shallow Farmington soils. (2) Fair stands of hardwoods are found on the wetter depressions of the Farmington soils. (3) Peat lands have a very low potential for both agricultural and forestal crops.

The following description of Rubicon sand represents the soil development on coarse materials similar to the Uplands but on sites where the water table is comparatively high for at least part of the season.

A_0—1½"—Mat of leaf litter.

A_1—1" —Grey-brown loamy sand; pH 5.4.

A_2—5" —Ashy-grey leached sand; pH 5.0.

B—5" —Dark reddish-brown loamy sand frequently indurated; pH 4.8.

G —14" —Pale yellow-brown sand, mottled with rusty-brown spots; pH 5.5.

C— Grey sand and in some cases gravel. Carbonates are commonly absent in sand and low in gravel; pH 5.8.

Soils are broadly classified by the type of soil formation which is common on the well-drained sites within a soil zone, since these reflect the normal effect of the regional climate and the vegetation associated with it. They are the normal or zonal soils. Because of local variations, the type of soil development within a zone may differ from that of the zonal soil, the degree of variation depending on the extent to which these local influences modify the effect of climate. The site may be poorly or excessively drained, or have some geological characteristic which interferes with the soil-weathering processes. On such sites there is a characteristic type of vegetation and associated soil development. These are called intrazonal soils for, while they do vary with climate, they do not change to the same extent as the zonal soils and consequently may be found in more than one soil zone.

The soil mosaic of Carleton County is a combination of patterns from both the grey-brown podsolic and the brown podsolic zones. The zonal grey-brown podsolic soils and commonly associated intrazonal soils are found on the higher lime materials chiefly in the southern portion of the county, but extend in tongues to the northern extremity. The main intrazonal types are the poorly drained soils developed under an elm-ash forest and characterized by a surface soil in which the organic matter is well mixed with the mineral matter. The brown podsolic soils are found on the well-drained sandy loams low in lime. The podsols are considered intrazonal soils since they occur on excessively or imperfectly drained sites.

Local Soil Variations (Catena, Series, Types and Complexes)

Local variations within the broad regional soil divisions are largely associated with differences in geological materials, topography, drainage and accompanying variations in local climate and vegetation.

Both the structure and chemical composition of the parent geological material have a strong influence on the development of the soil and its suitability for crops. This influence of the parent material upon the soil type is stronger in Carleton County than in most areas in Southwestern Ontario, owing to the comparatively short time the materials have been weathering. (See Part II.) The structure of the soil and its permeability to water and plant roots depend largely on the geological structure. The petrographical and the chemical nature of the parent materials largely influence the inherent soil fertility, not only in respect to the total supply of plant nutrients but also to factors affecting their availability. The climatic soil groups may then be divided into soil groups having similar parent material in respect to structure and chemical (or rock) composition. Such a grouping has been termed a catena (Milne) or association (Ellis). The physiographic divisions described in Part II form the basis for the divisions into catenas.

With some exceptions the soils of the area were classified into series, types and phases. These are divisions within the catena on descending categorical levels. The series includes all those soils which are developed from similar material and show the same genetic horizons in the profile. It is given a geographical name, usually that of some local feature commonly associated with the area where the series was first mapped. The type includes those soils within a series which have a similar surface texture. The class name of the soil texture such as clay, loam or sand is added to the series name to give the complete name of the soil type. The soil type is the principal unit of mapping. The phase is a subdivision of the soil type covering departure from the typical soil characteristics insufficient to justify the establishment of a new type, yet worthy of recognition. Phase variations may cover slope, erosion, stoniness and, in some cases, drainage, depth of horizons, depth of bedrock, etc. Where the soil areas are not sufficiently uniform to map on a soil series basis, the mapping unit becomes a soil complex. For example, it is impractical to map out all the variations in profile development of the shallow limestone soils so

*Milne, G. A.—A provisional soil map of Eastern Africa. East African Agr. Res. Sta. 1936.

†Ellis, J. H.—A field classification of soils for use in the soil survey. Scientific Agriculture, Vol. 12, No. 6, 1932.

that it is correct to consider the Farmington, as mapped, a complex rather than a series. While there is no provision in the following key to indicate which mapping units are types and which are complexes, the degree of uniformity may be determined from the soil descriptions.

Soil Descriptions

In the following key the soils of Carleton County have been differentiated first on the geological structure of their parent material, secondly on petrographical (rock) composition and thirdly on drainage. The mapping units are either types, phases or complexes. The range of profile characteristics in all cases is the final criterion on which the soils have been separated.

TABLE 7

KEY TO SOIL TYPES OF CARLETON COUNTY

	Map Symbol	Acreage	Per Cent of Total
A. Soils Developed on Till.			
1. Till composed largely of loamy, siliceous limestone materials.			
(a) Well-drained:			
(1) Grenville loam	Grl	40,300	6.9
(2) Grenville loam; boulder phase	Gr-b	1,900	.3
(3) Grenville sandy loam	Grs	1,300	.2
(b) Imperfectly to poorly drained:			
(1) Lyons loam	Ll	4,500	.8
2. Till composed largely of loamy, siliceous materials (Precambrian acidic rocks with a small percentage of Precambrian limestones).			
(a) Well-drained:			
(1) Galesburg sandy loam	Gsl	4,500	.8
3. Till composed largely of clayey materials (chiefly of Utica and Lorraine Shale origin).			
(a) Imperfectly drained:			
(1) Ellwood clay loam	Ecl	2,900	.5
B. Soils Developed on Roughly Stratified Sands and Gravels.			
1. Materials largely siliceous but with a significant proportion of shales and limestones.			
(a) Good to excessive drainage:			
(1) Kars gravelly sandy loam	Kg	22,400	3.9
2. Materials largely of shale origin.			
(a) Good to excessive drainage:			
(1) Leitrim gravelly loam	Lg	1,900	.3
C. Soils Developed on Water-laid Materials.			
1. Soils developed from limy grey clays and silts (occasionally gritty).			
(a) Imperfectly drained:			
(1) Carp clay loam	Ccl	28,100	4.8
(b) Poorly drained:			
(1) North Gower clay loam	NGc	63,000	10.7
(2) North Gower clay loam, shallow-muck phase	NG-m	9,300	1.6
2. Soils developed from grey-brown clays and silts, low in lime.			
(a) Imperfectly drained:			
(ai) Podsolic type of development:			
(1) Rideau clay	Rc	17,300	3.0
(2) Rideau clay—sand-spot phase	Rc-s	22,100	3.8
(3) Rideau clay—rock-knob phase	Rc-R	10,200	1.7

	Map Symbol	Acreage	Per Cent of Total
(aii) Podsol type of development:			
(1) Renfrew clay	Rec	1,100	.2
(2) Renfrew clay—compact subsoil phase	Rec-s	1,100	.2
3. Soils developed from pink and grey clays usually low in lime.			
(a) Imperfectly drained:			
(1) Bearbrook clay	Bc	2,900	.5
(2) Bearbrook clay, sand-spot phase	Bc-s	2,600	.4
4. Soils developed from limy lacustrine loams.			
(a) Imperfectly drained:			
(1) Osgoode loam	Ol	21,400	3.6
5. Soils developed from deltaic fine sands and silts low in lime.			
(a) Imperfect to poor drainage:			
(1) Castor silt loam	Cfs	15,400	2.6
6. Soils developed from shallow deposits of fine sands and silts over clay, low in lime.			
(a) Fair natural drainage:			
(1) Manotick sandy loam	Msl	10,600	1.8
(b) Imperfect to very poor natural drainage:			
(1) Allendale sandy loam	Asl	2,900	.5
7. Soils developed from deltaic gravels and sands.			
(a) Excessively drained (Podsol development):			
(1) Uplands sand	Us	13,100	2.2
(b) Imperfectly drained (Podsol development):			
(1) Rubicon sand	Rs	35,200	6.0
(c) Poorly drained (Podsolic glei soils):			
(1) Granby sand	Gs	12,500	2.1
(2) Granby sandy loam	Gl	1,300	.2
D. Shallow Soils over Bedrock.			
1. Soils developed from shallow drift over limestone bedrock usually containing a large proportion of limy materials.			
(a) Drainage variable:			
(1) Farmington (not differentiated)	F	89,600	15.3
(2) Farmington shingly loam	Fg	9,900	1.7
(3) Farmington sandy loam	Fsl	13,400	2.3
(4) Farmington loam	Fl	19,900	3.4
(5) Farmington clay loam	Fc	3,500	.6
2. Soils developed from shallow drift over sandstone bedrock—usually containing large proportions of siliceous materials.			
(a) Drainage variable:			
(1) Nepean sand	Ns	8,000	1.5
3. Soils developed on shallow drift over Precambrian limestone, etc., usually containing fair proportion of non-acidic materials.			
(a) Drainage variable:			
(1) Chandos	C	5,400	.9
4. Soils developed on shallow drift over Precambrian granite and gneiss, largely siliceous and containing practically no limy materials.			
(a) Drainage variable:			
(1) Anstruther	A	16,600	2.8
E. Soils Developed from Eroded Sands.			
(a) Excessively drained:			
(1) Bridgman	B	300	.1
(2) Eastport	E	1,600	.3
F. Soils Developed on Flood Lands along Stream Courses.			
(a) Bottom land	B.L.	7,100	1.2

	Map Symbol	Acreage	Per Cent of Total
G. Soils Developed on Organic Materials.			
(a) Well decomposed:			
(1) Muck	M	55,400	9.5
(b) Poorly decomposed:			
(1) Peat	P	5,100	.8

DISCUSSION OF SOILS

A—1. Loamy Limestone Till Soils

The Grenville loam is the dominant soil developed on those sections of the till plain where the soil materials consist, in large part, of the sandy Beekmantown limestone. The surface form and geologic structure of these materials have been discussed in the section on soil-forming factors. This type occupies the better drained sites on the drumlins and other undulations of the till plain. The Grenville sandy loam is found in local areas where the till is either more sandy or where it has been covered by sandy outwash. Both types of the Grenville series, however, include a range of drainage conditions varying from excessive on the steeper and more open portions to imperfect on the slight undulations and lower drumlin slopes. The Lyons series, represented in the county by the Lyons loam, includes all the associated areas ranging from imperfect to very poor natural drainage.

Grenville Loam (40,300 acres)

Description

The Grenville loam is a well-drained, undulating, morainic soil fairly well supplied with lime and plant nutrients. It occurs in North Gower and Osgoode townships.

The topography is commonly strongly undulating. The long, oval whale-backed hills or drumlins are a dominant feature. On some of the drumlins, some steeper slopes occur. In other places, the topography flattens out into gently undulating areas.

Both externally and internally, the drainage is good to rapid in the Grenville loam. On the gentler slopes, areas of imperfect drainage may occur where a compact layer restricts both drainage and root penetration. A separate series was not established and local areas were included with the Grenville or, in some cases, with the Lyons.

The present forested areas are confined chiefly to small woodlot areas where the beech-maple association is dominant. Early settlers record a large percentage of hemlock in the original forest growth. Basswood, yellow birch, ash and ironwood are fairly common. In permanent pastures, Kentucky blue and Canada blue are about equally abundant.

The following is a generalized description of soil profiles examined under a maple-beech association on lot 35, concession V, Osgoode Township. Beech and maple were the dominant tree species, although stumps indicated that the original forest had contained a fairly large percentage of hemlocks. (See also Figure 8.)

A_0— Thin layer of matted leaf litter.

A_1—3″ to 5″—Dark brown friable loam with few stones; no free carbonates; pH 7.0.

A_2—5″ to 10″—Light brown friable loam containing few stones; earthworms present; many small roots interwoven with the mineral soil; no free carbonates; pH 6.5.

B_2—4″ to 12″—Moderate yellow-brown, compact stony loam; a few small roots; no free carbonates; pH 6.8.

B_3—2″ to 6″—Yellow-brown, compact stony loam; few small roots; no carbonates; pH 7.0.

C— Yellow-grey, compact stony loam; few small roots; carbonates present; pH 7.8.

The parent material consists of rough, unassorted till. There are many angular and slightly rounded stones and boulders throughout the profile. Where these are present in sufficient numbers to greatly obstruct cultivation, the soil is mapped as Grenville loam (boulder phase). Many of the larger stones have been cleared off the Grenville loam so that present appearance does not adequately indicate the original quantity of stone present. The stones are varied in nature though largely of Beekmantown limestone. In local areas, other limestones occur in sufficient quantities to influence the profile. In the vicinity of Ottawa and in the southwest of Osgoode Township, where the proportions of Trenton and Black River limestones in the parent material were locally high, the profiles are shallower, the B more clearly defined and in other ways tending toward the Otonabee loam type of Peterborough County.

Where the ridges are prominent, as in the North Gower area, marine waters reworked the till materials, removing the finer particles and leaving faint bars and beaches. Such local areas, often included in mapping with the

Grenville, are much lighter in texture, often bouldery, and have profile development similar to the Kars gravelly sandy loam. This condition is common in the North Gower and Manotick areas, and where possible has been separated in mapping as the boulder phase. Where the relief is smoother, for example, in the Metcalfe area, the marine waters have often deposited a shallow layer of clay causing the upper horizons to be heavier in texture.

The surface soil in the cultivated field consists of a brown or dark-brown loam, five to seven inches thick. The natural fertility is medium. The content of organic matter and of nitrogen is medium to low. The reaction is neutral to mildly alkaline (pH 7.0 to 7.9) and, according to chemical tests, the levels of available phosphorus and potash are low while that of available calcium and magnesium are good. (See Part V.)

Utilization

Originally supporting good stands of hardwood, most of this soil is now cleared and used for agricultural purposes. General farming and dairying are the chief types. It is well adapted to corn, alfalfa and clover and fairly well suited for small grains, potatoes, turnips and mangolds.

The compactness of the till is not sufficient to prevent the soil from being easily worked once the stones have been removed. In consideration of moisture relations, there are many areas which tend to have a structure which is too loose and open for the best production of general farm crops.

Since dairying is common, a good supply of barnyard manure is usually available to return to the soil. Clovers will grow well and they help to maintain and replenish the organic matter supply as well as to add nitrogen. Commercial fertilizers should increase the yields when properly used. Potash and phosphorus are the main requirements for clovers and alfalfa. For grain and corn it generally pays to add nitrogen to the mixture. The soil contains a good supply of lime so that its addition will not likely show any marked effect.

Many of the prosperous farms in the county are located on mixed areas of Grenville loam and heavier stone-free soils with poor natural drainage such as the North Gower and Osgoode series. The well-drained soils of the Grenville series provide excellent building sites and suitable soil conditions for the growing of crops requiring good drainage and aeration. The heavier, more poorly drained soils are used for crops which are not so exacting in their requirements and can draw upon the greater reserve fertility of these soils. Under such a combination, the farmer seems to be able to get the most out of both types.

Grenville Sandy Loam (1,300 acres)

Description

This soil is similar to the Grenville loam in that it is developed on an undulating till plain of materials derived chiefly from Beekmantown limestone. It has, however, a shallow layer of sandy loam and sand over the stony loam till. In some places the sandy material is of plough depth, but in others it may extend downwards for several feet or may be underlain by roughly stratified sand and gravel in a kamelike formation. A small acreage of this soil was

mapped near the border of Grenville county. In addition to this acreage there are smaller areas near Manotick Station which have not been separated from the Grenville loam on the detailed-reconnaissance maps.

The topography is strongly undulating. Both internal and surface drainage are rapid. The natural tree growth on this soil is much the same as on the Grenville loam, with a few more pine and hemlock mixed in with the hardwood.

The following is a generalized description of a virgin profile of Grenville sandy loam.

A_0— Thin layer of matted leaf litter.

A_1— 3″ to 4″—Grey-brown sandy loam.

A_2—15″ to 20″—Pale yellow-brown sandy loam.

B_2— 1″ to 3″—Moderate yellow-brown loam.

B_3— 3″ to 6″—Yellow-brown sandy loam; no free carbonates.

C— Stony, sandy loam and loam fairly high in carbonates.

The cultivated surface is a greyish-brown sandy loam five to seven inches thick. It is a fairly pervious soil, medium to low in natural fertility. In some places the more sandy material may extend downward for several feet or may be underlain by roughly stratified sand and gravel in a kamelike formation. In the latter, the profile resembles the Kars gravelly sandy loam. The upper layers are slightly to medium acid.

Utilization

A proportionately greater acreage of this soil is in woodlot and pasture than that of the Grenville loam. The cultivated crops are similar to those grown on the Grenville loam, but with a slightly lower average yield.

Liming for clovers grown on this soil type should give beneficial results. The content of organic matter is usually comparatively low where the soil has been cultivated for a long time, and this should be replenished by frequent applications of manure and by plowing down crop residues. Complete fertilizer mixtures should give good results.

Lyons Loam (4,500 acres)

Description

The Lyons loam is a poorly drained, stony, morainic soil. In Carleton County it is associated with the Grenville series, occupying the more level and depressional areas of limestone till. It may also occupy slopes where seepage maintains poor drainage conditions. It occurs in small scattered areas in association with the Grenville and Farmington series.

The Lyons loam is commonly found in depressions where the general topography varies from gently undulating to nearly level.

The natural drainage is very poor. This soil receives much of the seepage and surface water from the higher surrounding areas. The drainage of Lyons loam could be greatly improved by deep open ditches, but these are difficult to construct on account of the numerous stones and boulders. Tile are even more difficult to instal.

The typical tree growth on this soil consists of cedar, spruce, poplar, aspen, soft maple, hemlock, birch, willow, larch and alder.

The following is a generalized description of the profile development on the poorly drained locations.

A_0— Thin mat of leaf litter.

A_1—6″ to 8″—Dark greyish-brown stony loam fairly high in organic matter.

A_2—2″ to 6″—Grey-yellow loam.

G—6″to 24″ —Grey-brown stony loam mottled with rusty brown, often high in carbonates.

C_2— Yellow-grey, compact stony loam, high in carbonates.

The surface soil is a very dark greyish-brown, friable loam six to eight inches deep. This is underlain by a compact, greyish loam usually highly mottled and streaked with yellow and brown. Varying amounts of rock fragments and boulders occur throughout the soil and on the surface. Some included areas, especially those associated with the Grenville sandy loam and Kars gravelly sandy loam are more sandy and contain fewer stones than typical Lyons loam and are somewhat similar to the Granby sand. The profile is usually neutral to alkaline throughout.

Utilization

Only a small percentage of the total area is cultivated, on which such crops as buckwheat, corn and timothy hay are grown. Most of the area is used for pasture or timber.

The natural fertility levels of this soil are medium. It is quite productive when the drainage has been sufficiently improved. The stoniness and compactness of the subsoil makes improvement for some types of crops impractical. The use of manure or fertilizer would be of little value on this soil in its natural, poorly drained condition.

A—2. Loamy Siliceous Till Soils

These are stony, sandy loams developed on till in which acidic Precambrian materials predominate. There is, however, a fair proportion of limestone (Precambrian or Paleozoic). These materials are usually laid down in broad drumlinoid ridges. The Galesburg sandy loam is the only type mapped. Poorly drained areas on similar materials were included. Small areas of this soil occur in the northwest corner of the county.

Galesburg Sandy Loam (4,500 acres)

Description

The Galesburg sandy loam is a light, well-drained morainic soil with strongly undulating topography. It is slightly acid in reaction and of medium fertility. This soil is found in the northwest section of the county in the vicinity of Fitzroy Harbour.

The topography is strongly undulating. The external drainage is good. The internal drainage is good to rapid.

Pine, maple and beech are common.

The profile is fairly representative of the brown podsolic soils developed in transition areas between the grey-brown podsolic and the podsol zones. Brown dominates the colour profile. In virgin areas there is a dark grey-brown surface soil (A_1) high in organic matter, which is fairly well incorporated with the mineral matter. This is underlain by a grey leached layer (A_2) often so thin as to be barely noticeable. Underlying this is a horizon grading from light to dark yellowish brown (B). While this horizon doubtless contains some accumulation of leached materials, there is not the compaction commonly found in the grey-brown podsolic soils. Because of the shallowness of the grey leached layers, this lower horizon dominates the cultivated soil. There is a gradation from the dark brown of this horizon to the lighter browns of the stony parent material (the C). Stones are frequent throughout the profile. (See diagram page 30 and also Figure 8.)

The cultivated surface soil is a dark brown sandy loam four to six inches thick. It has a medium content of organic matter and a medium to low supply of plant nutrients. The reaction of the weathered profile is slightly acid while that of the parent material is near neutral.

Utilization

Although this soil is often associated with rough and broken areas, a fairly large percentage is under cultivation. General farming, dairying and beef raising are the chief industries. Except for frequent stones, this soil is easily

worked. With good management, facilitated by the favourable physical characteristics possessed by this soil, good to fair crops of grain, hay and pasture can be grown.

A—3. Heavy, Shaley Till Soils

A small acreage of soils in the county are developed on materials derived chiefly from Utica and Lorraine shales. These materials are spread out to form comparatively shallow ground moraine over shale bedrock. The heavy nature of the materials and the proximity of the bedrock restricts drainage. The Ellwood clay loam is the only type mapped.

Ellwood Clay Loam (2,900 acres)

Description

The Ellwood clay loam is an undulating morainic soil, with fair natural drainage and medium acidity. Small areas of this type occur in Gloucester Township in the vicinity of Ottawa.

The topography is gently undulating. The external drainage is moderate. The internal movement of water is moderate to slow, being facilitated by gritty materials and retarded by heavy substratum (bedrock, etc.).

Groves of hardwood (maple and oak) were the only forest vegetation noted.

The profile is that of a weakly developed, podsolic soil with grey-brown colours predominating.

The cultivated surface is a dark brown clay loam six to eight inches thick. Its organic matter content is low. The reaction is strongly to medium acid (pH 5.0–6.0). Below the surface is a light brown clay loam three to eight inches thick (A_2), grading into a darker brown clay loam commonly mottled with yellow and dark brown (B) or (G). The parent material consists of brown shaley till. Grit and small stones are common throughout the profile. The levels of available phosphorus, calcium and magnesium are low; that of available potassium is medium.

Utilization

Where this type occurs in a general farming district, fairly good crops of grain and hay are grown. A fair proportion lies in suburban areas and is devoted largely to pasture. The unweathered shale particles tend to make the soil more friable. However, the low-lime and organic matter content causes it to be quite plastic when wet. The general natural fertility is medium. Applications of nitrogenous and phosphatic fertilizers should prove beneficial. The content of organic matter and of nitrogen is fairly low.

Soils of the Gravelly Ridges and Plains

Two distinctive types have been mapped on the glacio-fluvial and beach deposits. The Kars gravelly sandy loam is the most extensive type being developed on limy siliceous materials. The Leitrim gravelly loam has developed on shaley, gravelly materials of similar origin.

Kars Gravelly Sandy Loam (22,400 acres)

Description

The Kars gravelly sandy loam is a light, excessively drained soil developed on an undulating terrain. It has a scattered distribution. The gravel ridges, though of considerable linear extent, are narrow and frequently intermittent in their occurrence above the general level of the lake-washed plains.

Under natural conditions the Kars developed under a forest of maple, beech, hemlock and pine. Elm is now locally common in many of the slight depressions.

The virgin profile exhibits the characteristics of the grey-brown podsolic soils, but in many cases is not well developed because of the coarse, excessively drained soil materials. The following is a generalized profile description under average moisture conditions:

A_0— Thin layer of leaf litter.

A_1—1″ to 3″—Grey-brown sandy loam containing some gravel and boulders.

A_2—8″ to 30″—Pale yellow-brown sandy loam.

B_2—1″ to 3″—Moderate yellow-brown sandy loam or loam.

C— Roughly stratified sands and gravel fairly low in carbonates; occasional limestone cobbles; some shale, but siliceous materials predominating.

The cultivated surface soil is a light grey-brown sandy loam four to six inches thick. Chemical tests indicate that it is comparatively low in all plant nutrients.

Utilization

In local areas such as the Bowesville district, this soil is extensively used for the production of potatoes. It is more widely used for general farm crops, but there are few good farms developed exclusively on this type without some specialization such as potatoes or truck crops.

Boulders may occur in the upper portions of the soil profile. (See Figure 7.) In many sections the removal of the stones from the surface presents about the same problem as on the stony tills of the Grenville series. The underlying materials, however, are more open than in the Grenville, and the cost of picking stones is not as soon repaid, except under specialized cropping. The type is not uniformly bouldery nor does the gravel come within a uniform distance of the surface. The most desirable formation is that where there is a foot or two of fine sand covering the gravelly and stony materials so that the stones do not interfere with cultivation. The limestone fragments have assisted in the formation of a clayey layer of accumulation, the (B) horizon, which is an aid in moisture control. This layer is not as well developed where the sand is deeper or where the gravel comes close to the surface.

This soil is naturally low in elements necessary in plant nutrition: nitrogen, phosphorus, potassium and calcium. However, crops and chemical tests on potato fields and gardens indicate that it can be built up to a comparatively high level. This requires a heavy application, not only of commercial fertilizer, but also of barnyard or green manure to maintain the organic matter at a suitable level.

Leitrim Gravelly Sandy Loam (1,900 acres)

Description

The Leitrim gravelly sandy loam, occurring chiefly in the northeast, is a gravelly soil made up largely of coarse shaley fragments with good to excessive natural drainage. It is generally undulating in topography, although there are local flattish areas where there is a few feet of shaley gravel over bedrock.

The following is a generalized description of the natural profile.

A_0— Thin layer of matted leaf litter.

A_1—1″ to 3″—Grey-brown sandy loam with many shaly fragments.

A_2—4″ to 18″—Yellow-brown sandy loam.

B_2—2″ to 6″—Dark yellow-brown sandy loam.

C— Shingly sandy loam containing numerous shale fragments.

D — Frequently shale bedrock occurs within a few feet of the surface.

The surface soil is a brown, gravelly sandy loam, medium to acid in reaction. There is little indication of extensive leaching in the light brown, gravelly loam which underlies the cultivated soil. There is a gradation from this to the dark brown layers, which in turn grades into the shaley parent material and decomposed bedrock.

Utilization

The small areas of this soil which occur in the county are used for general farm crops and pasture. Alfalfa appears to do particularly well.

The higher shale content means more clay and a better water-holding capacity than that of the Kars gravelly sandy loam.

C—1. Soils Developed on Limy Clays and Silts

The Carp and North Gower series have developed on greyish clays and silts moderately high in lime. They are found chiefly in those sections of the

marine plain which extend from Fitzroy Harbour in the northwest through the valleys of the Carp and Jock Rivers, and continuing southward and eastward among the drumlinized till areas of North Gower and Osgoode Townships.

These clays, in common with the others in the county have a fairly large proportion of materials originating in the Precambrian region to the north. There is, however, a varying amount of materials derived from the local limestone till as evidenced by the presence of calcium carbonate in fairly high amounts in some of the layers. Limestone grit is also found locally embedded in the water-laid layers. The reaction of the surface soil under moderate to very slow drainage conditions is neutral to mildly alkaline (pH 6.5 to 8.0). Neither the amounts of calcium carbonate nor the degree of acidity are uniformly distributed throughout these materials but, in general, they are higher in lime than those from which the Rideau, Renfrew and Bearbrook soils are developed.

Only a few small stream courses have dissected the plain to any appreciable extent. There are no large areas of well-drained soils. On the moderately drained areas a weak profile development is noted, comparable to that on similar terrain elsewhere in the grey-brown podsolic zone of Ontario.

A large area in the Carp Valley and smaller areas elsewhere, developed on a gently sloping terrain with moderate to slow drainage, have been mapped as Carp clay loam. More nearly level areas with slower drainage are common in North Gower and Osgoode Townships and appear on the map as North Gower clay loam.

In many of the depressional areas in North Gower and Osgoode Townships, a shallow deposit of muck has formed over the silty clay mineral deposits. The profile in undisturbed areas is that of a "half bog" soil and is distinctly different to that of the North Gower clay loam. These shallow muck areas, however, are intimately associated with North Gower clay loam. Over much of the cultivated areas the muck has been either burned off or incorporated with the mineral soil to form a high organic surface soil not unlike that of the North Gower clay loam. These factors made it practically impossible to separate the two types on a reconnaissance scale of mapping so that a phase of the North Gower was established to indicate where shallow muck areas frequently occur.

Carp Clay Loam (28,100 acres)

Description

This is a gently undulating soil with moderate to slow drainage and neutral to mildly alkaline in reaction. This type occurs mainly in the Carp Valley between Antrim and Fallowfield.

The topography is gently undulating. The gentle slope towards the Carp River provides a moderate to slow external drainage. Although a fairly heavy soil, the structure appears to favour a moderate internal movement of water.

Elm, ash and soft maple were dominant in the original forest with an occasional hard maple and pine. The elm–ash association favours the development of a soil in which the humus is well incorporated with the mineral portion.

The following is a generalized description of a Carp clay loam developed under forest and fair drainage conditions.

A_0— Thin layer of matted leaf litter.

A_1— 3" to 5"—Dark grey-brown clay loam.

A_2— 2" to 8"—Light yellow-brown clay loam.

B_2— 2" to 4"—Moderate yellow-brown clay loam.

G —12" to 24"—Grey-brown clay loam similar to the parent material but with yellowish and rusty-brown mottling.

C— Water-laid silt and clay loam frequently varved; occasionally gritty; carbonate content medium.

In most soils the development of the B horizon is weak and the transition between it and the G is very gradual. The G horizon is not as well developed as in the North Gower series.

The cultivated surface soil consists of a dark brown layer six or seven inches thick. The texture is commonly a clay loam or silt loam, although clays are occasionally found. Under natural conditions the structure is usually of the crumby type. The organic matter and nitrogen content is medium to high. Chemical tests indicate this to be a fairly well-balanced soil with the level of plant nutrients medium to high. The reaction of the surface is neutral to mildly alkaline (pH 7.0–8.0). The content of bases in the parent materials is medium.

Utilization

Most of the land has been cleared. It is well adapted to the growing of small grains, corn, alfalfa and other hay and pasture crops. General farming is common throughout. Beef-raising is general toward the north, while dairying is carried on in sections closer to Ottawa.

This soil, under natural conditions, possesses an excellent physical structure. The moisture relations are superior to many soils, e.g., the Rideau, as it has not the same tendency to dry out. However, where the maintenance of organic matter is neglected and the soil poorly managed in other ways, this soil becomes, in time, difficult to work and less productive.

The natural fertility of the soil is medium to high. Artificial drainage is required for maximum production. The fertility of this soil can be easily maintained through good farm practices associated with general farming, dairying and beef-raising.

North Gower Clay Loam (63,000 acres)

Description

This is a poorly drained clay loam, neutral to alkaline in reaction. Occurring on similar materials as the Carp, it is differentiated from it on the basis of drainage. The chief areas occur in the townships of North Gower and Osgoode, often in close association with the Grenville loam.

The topography is almost level to depressional. The drainage is slow both internally and externally. Where the clay is shallow over till, a very compact layer frequently forms at the junction, with the result that drainage is very restricted. Very poorly drained areas and seepage spots often occur at the base of drumlins.

Elm, ash, soft maple and cedar were the common trees in the original forest. In common with the Carp soils this vegetation has resulted in a surface soil in which the organic and mineral matter has been well incorporated.

The following is a generalized description of the profile developed under natural forest conditions:

A_0—1″ to 2″—Matted leaf litter.
A_1—6″ to 8″—Dark grey clay loam.
A_2—1″ to 5″—Light grey clay loam.
G —8″ to 20″—Blue-grey, clay loam with yellow or rusty-brown mottling.

There is seldom a distinct boundary between these horizons, and mottling may occur immediately below the dark surface layer. In some of the better drained areas near stream courses, etc., the profile is similar to the Carp.

The cultivated surface soil is a dark brown clay loam, silty clay loam or clay, six to eight inches thick. There are occasional included areas where the surface is a loam. The organic matter content is high. The reaction is neutral to mildly alkaline (pH 6.5–8.0). According to chemical tests the supply of available nutrients is medium to high.

Utilization

A fair proportion of this soil has been cleared but there are many bush lots and natural pastures remaining. General farming and dairying are common. Alfalfa is not generally grown. Otherwise, the type of crops are similar to those grown on the Carp. Improved drainage is more necessary on this type than on the Carp. The peculiar advantages possessed by farms having a combination of Grenville loam and North Gower clay have been discussed under the heading of the former.

North Gower Clay Loam (Shallow-Muck Phase) (9,300 acres)

Description

This phase was mapped where local deposits of shallow muck occur closely associated with the North Gower clay loam. In the cultivated areas much of the muck has been burned off or incorporated with the underlying mineral soil so that they may not be much different from the typical North Gower clay loam. This type was mapped in all burnt-over areas, no matter how great a depth of muck was present before burning.

This phase has a scattered distribution. There are three general districts in which it commonly occurs, viz., south of Vernon, north of Dalmeny, and in the northerly areas of North Gower.

The topography is almost level to depressional. The drainage is very slow, internally and externally.

The original vegetation was elm, ash, pine, and where the muck was deeper, cedar and spruce.

In undisturbed locations, an organic layer, three to twenty-four inches thick, overlies blue-grey clay (glei or G horizon). There is commonly little mottling in the clay owing to the high water table, which prevents alternate oxidation and reduction. If the drainage is partially improved, mottling occurs. The underlying materials are similar to those of the North Gower clay loam.

The profile in the cultivated fields is variable. Where the muck has been partly burnt off and the remainder well incorporated with the underlying mineral soil, the surface soil is a clay high in organic matter and mildly alkaline in reaction. Underlying this, a portion of the massive grey clay layer (glei) is usually found. This may be mottled with yellow or reddish brown.

Utilization

Much of this shallow muck land is still in forest and natural pasture. However, large areas have been cleared and support much the same type of farming as the North Gower clay loam.

The clearing and farming of this soil complex presents many problems. If the muck is too severely burned, the massive grey clay layer, very deficient in organic matter, becomes the surface soil. Without organic matter well incorporated with it, this layer is difficult to handle, is poorly aerated and does not contain a sufficient supply of available nutrients. If too much muck is left, unproductive areas are the result, for the reserve nutrient levels of the

muck are lower than the clay. It is a late soil in the spring and dries out in the summer. It is, therefore, necessary to leave a sufficient amount of muck to form a cultivated soil. This can be accomplished by burning when there is sufficient water to prevent complete combustion. The skilful blending of muck and mineral materials to form a productive soil requires time and an experienced operator.

The nutrient minerals of the underlying clay are medium to high but are available to the plants only under favourable physical conditions. This can be procured only by the addition of humus either as muck, farmyard manure or plant residues. Since the muck is at hand in considerable quantities it can doubtless be used to advantage. The organic matter in manure and plant residues is more active, but it requires many years to build up to the required level with these materials.

C—2. Soils Developed on Grey-Brown Silts and Clays Low in Lime

The materials upon which these soils have developed have been discussed in Part II. In brief, they range from massive clays to laminated silts and clays. They have a fair supply of bases but there are no free carbonates. These deposits formed an almost level plain which is now broken by the erosion of post-glacial and present stream courses. Their texture is variable, ranging from a heavy clay to a silt loam. There are some very heavy clay areas. Mechanical analyses of samples taken from four widely separated locations indicate a content of 60 to 80 per cent clay less than .002 millimeters in diameter.

The natural vegetation and the soils which have developed on the eastern section of this plain of acid grey-brown clays and silts differ considerably to those which have developed on the western section. In the east, hardwoods are dominant where there is fair natural drainage. The soils are only moderately podsolized and therefore may be associated with the grey-brown podsolic soils. Conifers and more highly podsolized soils are found on the more poorly drained locations in the east. But in going from east to west the conifers become dominant over a wider range of soil conditions until, in the extreme west of the county, coniferous forests and podsol soils occupy the sites with fair drainage. While, in general, such a contrast in vegetation within a short distance may be associated with soil materials there seems to be no significant difference between those in the Orleans area as compared with those in the Arnprior area.

The more weakly podsolized type which has been mapped in all but the extreme westerly section has been included in but one series, the Rideau. The area is not exclusively Rideau clay, however, because much of the area has been covered by varying depths of sandy outwash materials. In many cases, these are less than three feet deep and occur as small patches widely scattered over the clay areas. This clay and sand complex was mapped as Rideau clay—sand-spot phase. Small, poorly drained areas of these materials were usually included with the Rideau. However, on the boundary between the Rideau and North Gower soils, certain poorly drained areas were included with the North Gower even though the soil materials more closely resembled those of the Rideau.

The podsol clay developed under forests dominantly pine and spruce has been mapped as Renfrew clay. It is a common type in Renfrew County where it occurs on clays and silts with fair natural drainage. Along the Mississippi

River there is a more poorly drained area of heavy clay in which the layer of accumulation becomes exceedingly compact. Owing to the restricted distribution of this poorly drained associate, a new series was not established but the condition mapped as Renfrew clay—compact subsoil phase.

Rideau Clay (17,300 acres)

Description

The Rideau clay is a very heavy, moderately drained stone-free soil, slightly to medium acid in reaction. The distribution of Rideau clay, as mapped, is comparatively limited. Small areas are indicated on the map near Ottawa along the Ottawa and Rideau Rivers. Similar and somewhat siltier areas are found in the townships of South March, Torbolton and Fitzroy.

The topography is gently undulating. The external drainage is moderate but the heavy clay layers cause slow internal drainage.

The original forest vegetation was a mixed hardwood and pine association.

The following is a generalized description of typical profiles occurring under forest vegetation:

A_0— Thin layer of matted leaf litter.

A_1—2″ to 3″—Grey-brown clay.

A_2—1″ to 4″—Light yellow-brown clay.

A_3—1″ to 4″—Speckled light and yellow-brown clay.

B_2—2″ to 4″—Moderate yellow-brown clay.

G —3″ to 8″—Grey-brown clay mottled with yellowish and rusty brown.

C— Massive and laminated brownish-grey clay.

In many sections the B horizon is very poorly developed, and there is a gradual change from the light yellow-brown A_2 through the mottled glei to the slightly weathered parent materials. Stones do not occur in any part of the profile.

The cultivated surface soil is a heavy grey-brown clay five to seven inches thick. The organic matter is medium to low. The reaction is slightly to medium acid (pH 5.5–6.5). According to chemical tests the level of available phosphorus is medium to high. The available potash ranges from high in the clays to medium on the lighter silts. The replaceable calcium ranges from medium to high while the magnesium is uniformly high.

Utilization

Most of the Rideau clay has been cleared. Owing to its heaviness, a large proportion is utilized for pasture. Under good drainage conditions it is adapted to the growing of hay and small grains.

The physical characteristics of this soil are its chief limiting factors. Its heavy texture makes it difficult to manage. It puddles when wet and bakes when dry. For best results, it must be worked only when the moisture conditions promote the best friability. But even under the best management, the moisture relations are difficult to control. Though generally requiring artificial drainage for the removal of excess water in wet periods the Rideau becomes somewhat droughty when dry weather sets in.

Erosion problems occur within a very small fraction of the total area but are locally serious. Gullies erode easily in this heavy clay. Particularly deep gullies are formed when comparatively small streams or ditches flow into the Ottawa and Rideau Rivers from the plains which are considerably higher than the level of the river. Sheet erosion is also serious in areas adjacent to stream courses.

The general natural fertility of the Rideau clay is medium, productivity being chiefly limited by physical characteristics.

Rideau Clay, Sand-Spot Phase (22,100 acres)

Description

This is predominantly a heavy soil. Clay comes to the surface over most of the area and underlies patches of sand at less than three feet in the remaining spots. The characteristics of the Rideau clay apply to the clay portions of the areas. The deeper sand areas resemble Manotick sandy loam. Intermediate conditions exist usually in concentric zones around the sand, extending out to the clay. All the range of textures from sand to clay are found. Other characteristics are also of an intermediate nature. The main areas of this type occur in the immediate vicinity of Ottawa.

The topography is gently undulating. The external drainage is moderate. The internal drainage in the clay is moderate to slow. The water moves more rapidly through the sand, but where the sand is shallow there is usually a very impervious layer at the juncture of the clay and sand, and the drainage may often be slower under these conditions than in soils with clay throughout.

Pine was a dominant species in the original forest as indicated by the numerous stump fences which were common on this type until a few years ago. There was also a good sprinkling of hardwoods.

The profiles of the clay areas are similar to the Rideau clay; those of the deeper sand resemble the Manotick sandy loam. In the intermediate areas sand, sandy loam, loam, and clay loam overlie the clay to depths up to three feet.

Utilization

The utilization of this soil is similar to the Rideau clay. Possibly a greater proportion of it is devoted to general farm crops. Its proximity to the markets of the city of Ottawa has resulted in the establishment of many fine dairy farms. It is fairly well adapted to the growing of small grains and hay.

The widely varying textures of the two components of this soil complex makes management a difficult problem. The water moves more rapidly through the sand than the clay. The sand spots present difficulties in pasturing and in the maintenance of fertility levels. Heavier applications of barnyard manure on these spots tend to build up the fertility and maintain a better sod.

Rideau Clay, Rock-Knob Phase (10,200 acres)

The rock-knob phase of the Rideau clay is developed on clay and silt materials which have been deposited as a shallow mantle over undulating Precambrian bedrock occurring in the northwestern portion of the county.

The topography is gently to strongly undulating. Knobby outcrops of bedrock are common. The drainage is more variable than in the Rideau clay with larger areas fairly well drained. In the clay depressions and rocky pockets the drainage is poor.

The vegetation frequently contains more pine than the Rideau clay and the profile is generally more intensely leached, in many places more closely resembling the Renfrew. The surface soil is a moderate yellow-brown, somewhat lower in plant nutrients than the Rideau clay.

Utilization

This soil is used fairly extensively for general farming and grazing. Under good management, the large pockets and ridges of deeper clay and silt produce crops equally as well as the Rideau clay. Production on the shallow and eroded areas, however, is poor. The productivity rating of the type is variable, depending greatly on the degree to which rocks and gullies break into the farm unit. Suitable management of the better areas is similar to that necessary for the Rideau and Renfrew clays, although more consideration must be given to erosion control than in most areas of the Rideau series.

Renfrew Clay (1,100 acres)
Renfrew Clay, Compact Subsoil Phase (1,100 acres)

Description

The Renfrew clay occurring in the northwest of the county is a heavy, moderately drained soil. Its leached layer has the ashy grey colour of the podsols.

The topography is gently undulating. There is usually a gentle slope towards the small stream courses which dissect the plain. The external drainage

is moderate, but the internal drainage is usually slow to very slow owing to the impervious B.

This soil has developed under a vegetation dominantly pine and spruce.

The following is a generalized description of profiles developed under natural forest vegetation of pine, white spruce and aspen.

A_0— ½" to 1½"—Matted leaf litter.

A_1— ½" to 1½"—Dark brown clay with a high content of organic matter.

A_2—2" to 4" —Light grey, silty clay loam.

A_3—1" to 3" —Pale yellow clay speckled with brown.

B_2—4" to 16" —Compact heavy clay, ranging from light to dark yellow-brown.

G —3" to 12" —Grey-brown clay with rusty or yellow-brown mottling.

C— Grey-brown plastic clay.

Stones do not commonly occur anywhere in the profile. The cultivated surface soil is a light grey clay as a result of the inclusion of the grey leached A_2 in the surface soil. The organic matter and nitrogen content is low. According to the few chemical tests available, the levels of available phosphorus, potassium, calcium and magnesium are about medium.

Utilization

More than half of this soil has been cleared and many areas are producing good hay and cereal crops. Much of the compact subsoil phase has been left in pasture, owing to the acid reaction, poor physical condition of the soil

and the restricted internal drainage. In common with the Rideau, this soil suffers from excess moisture in wet seasons but is droughty when the weather becomes dry.

Apart from the limitations which are fixed by the physical characteristics of this soil the fertility levels are naturally medium.

C—3. Soils Developed from Acid Pink and Grey Clays

Along the eastern boundary of the county there are small areas of soils developed on the pink and grey clays more widely distributed throughout Russell and Prescott counties. While throughout the broader area a range of soil types occurs, only a few of these are found in Carleton County in areas sufficiently large to indicate on the map. The Bearbrook is the only series mapped.

The mode of deposition of these water-laid clays has been discussed in Part II. The grey or blue-grey layers are thicker and contain more silt. They appear to have a fair proportion of local shaley material mixed with the more acid materials, brought in from the north. The lime content is medium to low. The lime content and reaction of the grey layers are much the same as that of the grey-brown clays of the Rideau. The pinkish layers usually do not contain free carbonates except where there is a fair proportion of gritty fragments of Medina shale.

Bearbrook Clay (2,900 acres)

Description

This is a gently undulating heavy clay soil, medium acid in reaction and with fair to poor natural drainage. For the most part it is located along the eastern border of the county. Small, poorly drained flats have been included in mapping. The internal drainage is slow.

Elm, hard maple, soft maple and pine were dominant in the original forest on the better drained locations, while pine and spruce were common on the poorly drained areas.

The following is a description of a generalized profile developed on the better drained sites under a mixed forest.

A_0—Very thin layer of matted leaf litter.
A_1—1″ to 3″—Dark grey-brown clay.
A_2—1″ to 3″—Yellow-brown clay.
B_2—2″ to 6″—Brown clay.
G —2″ to 10″—Brown clay mottled with rust.
C —Alternate layers of pale pinkish-brown clay and grey-brown clay or silt.

On the more poorly drained areas the A_0 is thicker, the A_1 thinner, the A_2 shows greater leaching, and the mottled glei replaces the B entirely.

The surface soil in the cultivated fields varies from a light to a dark grey-brown heavy clay. The organic matter is generally quite low and, although somewhat higher on the poorly drained locations, it does not readily incorporate with the mineral soil. This is due largely to the acidity of the soil materials, as witness the better amalgamation in the limier clay loams of the Carp and North Gower series. The heavy texture of the Bearbrook, its low lime content

and the nature of its organic matter tend to inhibit the formation of a good structure in the surface soil.

Utilization

General farming and dairying are the chief types of agriculture found on the Bearbrook clay areas. Hay and pasture crops predominate with a proportionately small acreage of grain.

The poor physical structure of this heavy soil can be improved by the application of organic matter and lime, and by cultivating under proper moisture conditions. Unless it is carefully handled it puddles when wet and when dried becomes very hard and baked. While artificial drainage is necessary to remove excess moisture, crops suffer from drought in dry seasons.

Apart from the lack of lime and of nitrogen, the Bearbrook is fairly well supplied with plant nutrients. According to chemical tests the phosphorus and potash content is high. The degree to which these are available to the growing plant depends largely on the structure and water relations. Good crops can be produced only by maintaining good tilth through the application of lime and organic matter and by careful handling when the soil is neither too wet nor too dry.

Bearbrook Clay—Sand-Spot Phase (2,600 acres)

Description

This is a complex soil condition in which the pink and grey clays of the Bearbrook series are irregularly covered with patches of acid sand seldom more than three feet in depth. In those portions where the clay has little or no covering of sand the soil is similar to the Bearbrook clay. The sand content of the soil increases till the texture approaches a loam around the edge of the "sand spot." The sand is commonly imperfectly drained. There are included areas of more poorly drained sand over clay which have the characteristics of the Allendale sand.

Utilization

This soil is frequently left in pasture as it is difficult to handle. The problems of managing the clay have been discussed under Bearbrook clay. The sand spots are lower in fertility. The drainage is imperfect, a condition often difficult to improve as the water moves freely through the sand and strikes an impervious layer at the juncture of the clay and the sand. The widely varying texture and associated characteristics of the surface soils make management a difficult problem.

C—4. Soils Developed from Limy Water-Laid Loam

The materials comprising the limy loam plains are a combination of marine clay (similar to the North Gower) and lighter materials washed in from the adjoining till and gravelly ridges. The intermixing has not been uniform. There are areas in which the materials are a uniform loam throughout the profile as in most of the area near Osgoode Station. In some places the upper layers are sandy loam with clay below the weathered soil. In other locations the clay comes closer to the surface. Along the Rideau River in the extreme south of the county, an area included with the Osgoode is characterized by a surface layer of clay loam, one or two feet thick over coarse sand. In this

and other areas, the materials may consist in part of alluvium deposited by the present streams during floods. Only one type, the Osgoode loam, has been mapped.

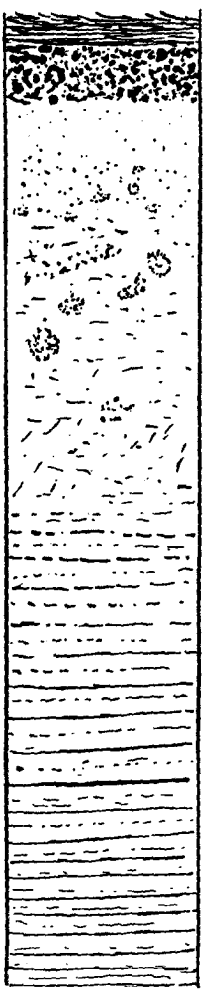
Osgoode Loam (21,400 acres)

Description

The Osgoode loam is an alkaline stone-free loam. The topography is quite smooth, frequently occupying the poorly drained basins between ridges of till or glacio-fluvial gravels. The external drainage is poor. The internal drainage is usually imperfect owing to the high water table. Once this is lowered, the internal movement of water is commonly free, owing to the comparatively open structure of the materials. Drainage is slowed up where there are thin layers of clay within the loam material and considerably restricted where the clay deposits occur close to the surface.

The dominant natural vegetation includes soft maple, elm and ash.

The following is a generalized description of the profile developed under the natural forest cover.



A_0—½" to 1"—Matted leaf litter.

A_1— 2" to 6" Grey-brown loam.

A_2— 1" to 4"—Pale yellow-brown loam (mottled in places).

G —12" to 30"—Grey-brown loam mottled with yellowish and rusty brown.

C— Grey-brown loam and clay loam, generally in layers; frequently contains grit; carbonate content medium.

On some of the better drained sites there is a weak B development.

Under natural vegetative conditions the surface soil is relatively high in organic matter which is fairly well incorporated with the mineral layer. Unless poorly managed, the cultivated surface soil is also high in organic matter. It has an excellent structure and is usually moderately well supplied with plant nutrients.

Utilization

Along the Rideau River, in the southern part of the county, this soil is highly developed for general farming and dairying. In other areas a similar type of farming is practiced, but the production of farm crops is not so high and there is a greater proportion of the land in pasture and bush.

Drainage is the chief physical limitation of this soil in its natural state. Once drained it possesses excellent physical characteristics (except in included areas where the lighter materials are underlain by clay at shallow depths). In general, however, the loamy materials are stone-free and are sufficiently open in nature to permit freedom of root and water penetration providing the water level is sufficiently low.

Except for the lighter areas this soil would appear to have a fair supply of plant nutrients since, at the present time, farmers who practice good soil management require little or no mineral fertilizers. According to the chemical tests the calcium, magnesium and phosphorus levels are medium high. The tests show the potash levels to be generally low except where the heavy loam or clay loam forms part of the soil profile.

C—5. Soils Developed on Deltaic Silts and Fine Sands Low in Lime

The deposits of acid deltaic silts and fine sands may be considered under two headings, depending on the depth of these materials over clay. Only the more uniformly deep types will be discussed in this section. Such a deposit is found in the Edwards district in the east of the county. Comparatively smooth and imperfectly drained, this area has been mapped as Castor silt loam. Only in included local sections within this area does the underlying pink and grey clay come within the soil profile. Throughout the rest of the county the silts, loams and fine sands are commonly shallow deposits of non-uniform depth over clay. The silts developed on this complex of intermediate and heavy materials are discussed in the following section.

Castor Silt Loam (15,400 acres)

Description

The Castor silt loam is an imperfectly drained soil of intermediate texture and slightly acid in reaction. Most of this type occurs in a single block in Osgoode and Gloucester Townships.

The topography is almost level. The most pronounced undulations result from the slight gully erosion occurring along the Castor River and Bearbrook Creek. The external drainage is slow, owing to the slight degree of slope. The internal drainage is also imperfect on account of the high water table. Settlers

report that "quicksand" conditions were common before the land was cleared. However, the materials are sufficiently pervious, and the facilities for improvement of outlets are such as to suggest that most of this type can be satisfactorily drained.

The original vegetation included soft maple, white birch, white pine, white and black spruce.

The following is a generalized description of the profile which is developed under a natural forest cover.

A_0— ½" to 2"—Matted leaf litter.
A_1—2" to 4"—Dark grey silt or fine sandy loam.
A_2—2" to 6"—Pale yellowish-grey silt or fine sandy loam.
G —4" to 13"—Pale yellow-brown sand, mottled with rusty brown.
C —Layers of brownish-grey silts and fine sands low in lime.
D —Varves of pink and grey clay occasionally occur within 3' or 4' of the surface.

Figure 9 illustrates a profile of a cultivated soil.

The surface soil of the better drained, cultivated areas is a grey-brown mellow loam, easily cultivated. Unless it has been well manured and limed, the organic matter is not high but is usually well incorporated with the mineral portion of the soil. On the more poorly drained, cultivated areas, the organic matter tends to remain in the raw, acid condition quite distinct from the mineral portion of the soil, a condition similar to that which prevails under natural conditions. The pH of the surface soil ranges from 6.0 to 7.0 with an occasional included area with a pH of 8.0, reflecting the influence of adjoining limy deposits. Such areas might, on a detailed survey, be correlated with the Osgoode loam. According to chemical tests the levels of readily soluble phosphorus and magnesium are medium high but the calcium and potassium levels are low.

Utilization

General farming, with emphasis on hay and pasture cropping, is the chief type of agriculture practiced on this soil. Since drainage has been somewhat improved in more recent years there has been a considerable increase in the acreage of potatoes.

Excess soil water is still the chief limiting physical factor in many sections. Once drained, the Castor possesses a good physical structure permitting optimum water and root penetration. Exceptions to this may occur where the silt content becomes so high that a good crumb structure is difficult to maintain. But in Carleton County it was a common observation that the content of the fine sand and clay was high enough to ensure the good structure which is characteristic of loamy soils. With improved drainage and the application of corrective amounts of lime, manures and mineral fertilizers, this soil can be made one of the most productive in the county. At the present time, however, its productivity is definitely limited in wet years by the imperfect drainage.

C—6. Soils Developed from Shallow Deposits of Fine Sands and Silts over Clay Low in Lime

Sections of the deltaic silt and fine sand plain are characterized by a very thin non-uniform covering of these intermediate-textured materials over clay. In general, the lighter materials dominate the profile but the clay is seldom more than four or five feet below the surface and frequently comes to the surface.

Two complexes have been mapped in Carleton County. The Manotick sandy loam is found on undulating areas where the drainage is fair. The underlying clay which appears at the surface is commonly the acid grey-brown clay of the Rideau and Renfrew series. A few small areas along the Rideau River, where the underlying clay materials are somewhat higher in lime, have been included in the complex.

The Allendale sandy loam was mapped where the complex of sand, silt and clay is poorly drained. In general, the terrain is smoother than that of the Manotick. The underlying clay is either the grey-brown type associated with the Rideau, or the pink and grey type similar to the Bearbrook.

While both of these types include areas where the soil profile may be developed entirely either on light or on heavy materials, the dominant characteristics are a combination of the two with the clay appearing in the B and lower horizons. While the same conditions may occur on the sand-spot phases of the Rideau and the Bearbrook, their occurrence is much more localized so that clay is more dominant over the area and hence they are included with the clay series.

Manotick Sandy Loam (10,600 acres)

Description

The Manotick sandy loam is a soil complex developed on an undulating plain of acid clay which has been covered by layers of fine sand and silts, the total thickness of which varies, though seldom exceeds four or five feet.

The topography ranges from slightly to strongly undulating. The drainage is variable, owing to differences in texture, depth, and slope of the successive layers. Poor drainage prevails where there are a few feet of coarse materials over a smooth, clay base. There is very little run-off. Practically all the rain water moves rapidly through the sand but is held up by the heavy clay. Materials washed out of the sand are precipitated at this point and tend to increase the impermeability of the lower layer. Frequently, however, the clay base of the Manotick is not level and a sideways movement of the water along the clay base occurs. Where the overlying materials are heavier, the run-off is greater and, with a decrease in the percolating water, there is less material precipitated to form a hard pan at the juncture of the loam and clay. Local included areas of loam over clay loam occur in which the profile does not show any marked evidence of restricted drainage.

The natural vegetation on the Manotick is variable. Pines are dominant on the lighter knolls. Hard maple, yellow and white birch are associated with the pines where the clay comes close to the surface. On the poorly drained depressions, white spruce and pine are common.

The profile varies according to the depth of the loam or sandy loam over the clay. The following is the description of a profile examined on Lot 23, Con. B.F., in the township of Gloucester.

A_0—	½″ to 1″	—Matted leaf litter.
A_1—	1″ to 3″	—Dark grey sandy loam.
A_2—	½″ to 1½″	—Light grey sandy loam.
B_1—	2″ to 3″	—Pale yellow-brown sandy loam.
B_2—	3″ to 5″	—Moderate yellow-brown sandy loam.
B_3—	6″ to 8″	—Moderate yellow-brown loam.
G —	16″	—Brownish-grey clay, mottled with rusty brown.
C —		Brownish grey clay.

In such an extremely variable complex it is to be expected that the cultivated surface soil will be far from uniform. In texture, it ranges from a sand to a clay with sandy loam predominating. In virgin forests dominated by pine there is a fairly thick, grey leached layer. Where the hardwoods are more common the grey leached layer is thinner. Cultivation results in a grey-brown surface soil with a fair supply of organic matter. A good structure can be maintained in this soil under good management.

The levels of plant nutrients are variable according to chemical tests. This is to be expected because of the variability of the surface and lower horizons. In the sandy loam samples, the calcium, potassium and magnesium levels were shown to be medium to low.

Utilization

The Manotick sandy loam is used largely for general farming, local areas being particularly well farmed. Within this soil complex there are conditions suitable for specialized crops, such as small and tree fruits adapted to the climate.

The variability of texture between surface and subsoil has both advantages and disadvantages. The disadvantages are chiefly those associated with drainage and have been discussed previously. If the drainage factor can be taken care of satisfactorily, there are certain advantages in the dual texture. The lighter upper horizons provide a satisfactory media for root growth, while the heavier layers have a larger reserve of plant food.

Because of its variability, the productivity rating of this soil complex cannot be adequately stated by a mean value. With the exception of the extremely light and extremely heavy portions, a good structure and plant nutrient level can be fairly easily maintained under good tillage and manurial practices. Generally there is good response to a balanced fertilizer.

Allendale Sandy Loam (2,900 acres)

Description

The Allendale sandy loam is an acid, poorly drained sandy soil in which there is clay commonly within three or four feet from the surface. There are a number of small areas included in mapping with such types as the Bearbrook

clay—sand-spot phase, Castor silt loam and Manotick sandy loam. The clay materials underlying the sand may be either of the pink and grey or of the grey-brown variety.

The topography is usually smooth with the occasional "swell" of a sandy knoll. Under such topographical conditions, the water table forms above the clay layer as described in the discussion of the Manotick, but in this case it is frequently closer to the surface. The natural drainage thus ranges from poor to very poor, except on the deeper sandy knolls where it may attain the status of an imperfectly drained soil.

The virgin forest growth consists chiefly of white and black spruce, cedar and tamarack and some pine.

The profile development is variable, depending on the depth of sand over the clay and on drainage conditions associated with this. The following generalized description of profiles developed under natural forest cover is typical of a large proportion of the area. The matted leaf litter (A_0) is one to two inches thick. The A_1 horizon is a dark grey sandy loam, two to four inches thick. Underlying this is a light grey sandy loam, one to four inches thick. This grades into a mottled, greyish-brown sandy loam, which in turn grades into yellow-brown sandy loam or clay heavily mottled and streaked with rusty brown. This, in turn, is underlain by blue-grey clay at depths of eighteen to forty inches.

Though the organic matter in the virgin soil is comparatively high, little of it is incorporated with the mineral portion. The cultivated surface soil, particularly the freshly broken areas, contains a mixture of raw organic matter and grey leached mineral soil. A good cultivated layer may be obtained by liming, draining and otherwise aerating the soil.

Utilization

Owing to the comparatively small area within the county, no definite statements can be made as to the specific use of this type. It would appear, however, that wherever small areas occur within a better drained area, they are largely devoted to woodland and pasture.

Physically, this soil is limited by drainage and by the sand–clay combination. The latter makes drainage more difficult and renders impractical a uniform method of tillage and management since the better drained sandy knolls require a different treatment to that of the poorly drained heavy depressions.

Chemically, too, this soil is variable although the variations are not as extreme as in soils with better drainage. In general, however, the proximity of the clay layer tends to provide the plants with a reserve of nutrients, once facilities for rendering these available have been provided.

C—7. Soils Developed from Deltaic Gravels and Sands

The topography and internal structure of the deltaic sand plains has been described in detail in Part II. For the most part, the materials consist of coarse sands although gravel deposits occur which are usually covered with sand. The coarser sand and gravel contains a small quantity of free carbonates

but, in general, the sands are low in lime. On the poorly drained sites much of the original lime content remains and is, in some cases, augmented by the infiltration of limy waters from adjoining areas.

A forest dominantly coniferous and a soil typically podsol occurs on the excessively and imperfectly drained areas, and a forest more dominantly hardwood with a podsolic glei soil on the poorly drained, more alkaline areas. On the strongly undulating to smooth upland areas with a low water table the Upland series was mapped. On undulating areas where the water table is close to the surface of the depressions the Rubicon series is found. In the more uniform, smoother depressions of limier sands, the Granby series occurs.

Uplands Sand (13,100 acres)

Description

The Uplands is an excessively drained acid sand. It is seldom bouldery although gravel and cobbles may occur close to the surface. Blow-out spots are common.

The topography is variable. Smooth upland areas bounded by steeper slopes are common. Owing to the coarse open nature of the soil materials the drainage is excessive, except where the water table is within five or six feet from the surface. Bluffs formed along the edge of the old channels are frequently subjected to wind erosion. The common natural vegetation is Jack and red pine.

The open nature and originally low lime content of the parent material and the coniferous type of vegetation combine to develop the podsol type of soil profile.

The following is a generalized description of the profile developed under natural forest cover. (See also diagram on page 31.)

A_0— ½" to 1" —Matted leaf litter.
A_1— ½" to 1½" —Moderately dark brown sand.
A_2—1" to 2" —Ashy-grey sand.
B_2— ½" to 1½" —Moderately dark brown sand.
B_3—26" to 60" —Pale yellow-brown sand.
C— Grey sand and gravel.

Where the gravel comes closer to the surface the profile is similar to the Kars.

The cultivated surface soil is commonly very low in organic matter and a single-grained sand structure is common. Chemical tests indicate that the available plant nutrients are all very low.

Utilization

While most of the Uplands sand has been cleared and cultivated at some time, much of it is now in grass. Drifting is common on the cultivated areas. Grain and potatoes are the chief crops. Suited to neither pasture nor grain crops, these soils should be devoted in large part to specialized crops such as potatoes or hops or be reforested.

They are deficient both in water-holding capacity and plant nutrients. The maintenance of soil moisture presents the most difficult problem as it is of no avail to apply commercial fertilizer without sufficient moisture. While chemical tests indicate all nutrients to be low, experiments appear to indicate that nitrogen is the prime requisite, with increased production upon the addition of potassium and phosphorus. The economic application of fertilizer, however, is definitely limited by the moisture supply. Good crops can be grown only occasionally either because of favourable climatic conditions, or where some local factor such as a retentive subsoil close to the surface provides sufficient moisture for the crop grown.

Rubicon Sand (35,200 acres)

Description

The Rubicon sand is an acid soil developed on an undulating plain in which the water table is close to the surface in the depressions and never more than six to ten feet below the surface on the knolls.

While the topography is generally slightly undulating, certain variations occur. The Rubicon sand mapped in association with the Kars gravel from Reid's Mills to near Manotick Station is, in the main, uniformly smooth with a temporary water table commonly within five feet of the surface under natural conditions. The drainage in this area is generally imperfect. In parts of the Rubicon areas, as in Gloucester and Goulbourn Townships, the topography becomes more undulating and the drainage varies from excessive to very poor within short distances.

A very thin profile develops on the excessively drained knolls, a ground water podsol on the imperfectly drained areas and a podsol-glei in the depressions. The following description is that of a ground water podsol found on imperfectly drained sites. The matted leaf litter (A_0) is one to two inches thick. The A_1 is a thin horizon of dark grey sand. This is underlain by an ashy grey A_2, two to five inches thick. Below this is a fairly compact, moderately dark brown, sandy layer eight to twelve inches thick (B) which in places becomes very hard. This horizon grades into a yellowish-brown sand mottled with rusty-brown. The transition between this layer and the underlying slightly weathered materials is also gradual. Below three to four feet the parent material is made up of grey sand, silt or clay irregularly stratified. (See diagram on page 32.)

The surface soil varies from a yellow-brown sand on the knolls to a dark grey-brown sand in the depressions. It is usually strongly acid. According to the chemical tests of samples taken from the imperfectly drained knolls, the level of available plant nutrients is low.

There are areas included in mapping, particularly in the Piperville district, where clay comes within three to eight feet of the surface and is responsible for the high water table.

Utilization

The utilization of this soil complex is variable, depending on the pattern of the soil variations and on its proximity to markets, etc. There are a number

of good farms practicing a general type of agriculture on this soil. For the most part these occupy the smoother, more uniform areas where the underlying materials are either limy gravel or clay. Potatoes are grown to a considerable extent on the deeper, better drained areas in some localities.

The open nature of the soil materials renders difficult the retention of moisture where the water table is low. The depressions usually require drainage, but to do this only accentuates the problem of moisture control on the knolls. Where the underlying clay is responsible for the high water table, drainage is frequently difficult to improve.

This soil responds to applications of lime, organic and mineral fertilizers. While it generally possesses better facilities for moisture supply than the Uplands it is only under special conditions that it is suitable for general farming. Dairying or some other form of stock-raising is a prime essential. Potato production is limited by drainage. Reforestation is a sound practice on many areas, particularly where the micro-relief is variable (i.e. where the open, excessively drained, grey soils of the knolls are in close association with the poorly drained, black soils of the hollows).

Granby Sand (12,500 acres)

Description

The Granby sand is a neutral to alkaline sandy soil with poor natural drainage. The topography is commonly smooth or depressional. Areas too small to map occur in association with the Rubicon.

The native vegetation consists largely of elm, soft maple, cedar, spruce and balsam.

The following is a generalized description of the profile occurring under natural forest cover:

A_0— 1″ to 2″—Matted leaf litter.
A_1— 5″ to 10″—Dark grey sand and sandy loam.
A_2— 1″ to 6″—Light grey sand.
G —10″ to 20″—Greyish-brown and yellowish-brown sand, with rusty mottling.
C —Stratified grey sands with occasional strata of clay and silt.
Substratum of clay at 3′ or lower in included areas.

The surface soil of the cultivated fields is a dark grey-brown sand. The organic matter is fairly well mixed with the sand. The reaction ranges from pH 6.0 to pH 8.0. Some of the Granby mapped in Carleton lies near the acid limit of the reaction range of this type. In spite of its originally high organic matter this soil is generally low in available plant nutrients.

Utilization

Very few good farms in the county have been entirely developed on Granby sand. Good crops of hay and pasture and fair crops of grain are produced where the drainage and fertility have been improved.

Drainage is one of the main requisites for agricultural production on these types. But often when this is accomplished the retention of water becomes a problem because of the coarseness of the materials, particularly if the organic matter content is permitted to become low. Although these are dark-coloured, rich-looking soils in their natural state, once the required drainage is effected the problem of applying fertilizers and maintaining and increasing the organic matter becomes dominant.

Granby Sandy Loam (1,300 acres)

The Granby is a poorly drained, neutral to alkaline sandy loam. It differs from Granby sand chiefly in texture and associated chemical and physical characteristics. Except in certain details associated with texture, the associated characteristics of the Granby sandy loam and the sand are practically the same. In fact, it is difficult to separate the two types on a detailed reconnaissance scale of mapping. The sandy loam areas possess a better water-holding capacity and a somewhat higher level of natural fertility and accordingly produce better crops when they are drained and fertilized.

D—1. Shallow Soils over Limestone Bedrock

In approximately one-quarter of the county, limestone bedrock comes within less than ten feet of the surface and, within this area, a large proportion is covered with less than three feet of drift. There are large areas, either bare or practically so, which are of little value either for forest or agricultural crops. The agricultural and forestal potential increases with the depth of drift, the rate of increase depending on the nature of the drift. That is, a much shallower layer of heavy drift is required for satisfactory production than what is needed if the soil materials are light and open. In Carleton County all soils in which the shallowness over limestone bedrock limits production have been mapped as Farmington, irrespective of the degree to which production is limited by shallowness and by variations in natural drainage.

Large areas in which the drift is commonly less than one foot over bedrock have been mapped as Farmington (undifferentiated). This includes those areas of deeper soils which are too small to be adequately mapped separately. In general, the soils in these undifferentiated areas are too shallow to warrant separation on a textural or drainage basis for this report.

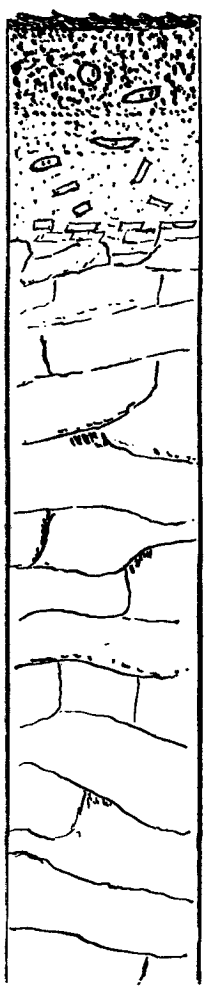
Those soils which are somewhat deeper, though usually not more than three to five feet, have been separated on a textural basis to constitute the shingly loam, sandy loam, loam and clay loam types. Since the character of the deeper soil materials have as great an influence on soil profile development as has the factor of shallowness, portions of these could well be mapped as series other than Farmington on a detailed survey. However, owing to the unevenness of the upper surface of the bedrock and of the drift itself, difficulties arise in making a separation at any arbitrary depth. For the purpose of this report it was felt that these areas of deeper soils should be mapped as types of Farmington, even though the profiles varied from the typical Farmington depending on the depth and type of soil materials. The separation, however, is a simple one based on texture only. For instance, shallow sandy loams are mapped as Farmington whether their materials resemble those of the Rubicon, the Kars or the Grenville sandy loam. As far as possible, this variation is

taken care of in the description. Even in these so-called deeper types, the depth to bedrock is still the dominant, if not the limiting, factor in crop production.

Farmington (Undifferentiated) (89,600 acres)

There are large areas in Carleton County where the limestone bedrock is either at the surface or within a foot of it. Within these areas and intimately associated with the shallow soils are somewhat deeper areas. However, these occur in such irregular areas and to such a small extent that they are difficult to separate except on a very detailed survey. This complex has been designated as Farmington undifferentiated.

The topography is generally level but is broken by frequent rocky ledges. The drainage is commonly excessive except in certain locations where the bedrock restricts the drainage of excess water in wet seasons. The profile varies. In very shallow soils there is seldom more than a thin organic layer over the rocky drift. In somewhat deeper soils, the dominant horizon is a moderately dark yellow-brown layer just below the organic layer as indicated in the following description:



A_0— Very thin layer of matted leaf litter.

A_1—3″ to 6″—Loam or sandy loam grading from dark grey-brown to dark brown.

C_1—0″ to 18″—Pale yellow-brown loam or sandy loam.

D— Limestone bedrock somewhat fragmented on the upper surface.

The included deeper areas have profiles similar to those described under the various types. The levels of available calcium and magnesium are generally medium to high; those of other nutrients medium to low.

Utilization

Forestry and grazing are the two chief uses of this soil complex. White cedar is common where there are a few inches of soil. In the deeper crevasses hard maple grows very well. In the original forest, maple was doubtless the dominant tree species on the shallow limestone plains. Since clearing, and the subsequent loss of organic matter and soil, the areas able to produce maple have been considerably reduced. Reforestation with either maple or cedar would appear to be highly desirable in many sections.

Large areas are devoted to grazing. This appears to provide the farmer with a substantial living, providing that he has sufficient acreage or can supplement his income from other sources. For crop production this soil must be considered a marginal type. Lack of moisture tends to render less efficient the methods of improving soil fertility which have proven economical on the other types. Large investments in fertilizers would be hazardous. However, clovers can be grown with fair success in favourable seasons. By growing clovers frequently and using all available farmyard manure and crop residues, a fair state of fertility can be maintained. Liming is not necessary.

The best planned economy for these lands would appear to be the establishment of comparatively large holdings for a single operator which would be largely devoted to grazing and forestry. The houses of the operators should be fairly well centred in a community so as to provide transportation and social facilities at a minimum of cost. Deeper pockets of soil could be used advantageously to provide for household needs. To a degree this is the present situation in many sections, as many of the farm buildings have been abandoned and the land taken over by neighbours. This has resulted in a very scattered settlement with many of the roads used very little and many of the schools abandoned.

Farmington Shingly, Sandy Loam (9,900 acres)

The Farmington shingly sandy loam is an excessively drained soil developed on undulating shingly ridges. These are composed largely of a matrix of angular stones ranging in sizes up to three inches in length, and through which are scattered materials ranging from a sand to a loam in texture. These ridges are the marine beaches discussed in Part II of this report. They may consist of a foot or so of shingly materials over the bedrock, in which case they differ little from the typical Farmington. But deeper deposits are more common, some of which are almost ten feet in depth. Toward the deeper extreme the soils are no longer typical Farmington, but have characteristics akin to gravelly soils such as the Kars. The long narrow strips of these deeper soils and their irregular distribution make it impossible to indicate them on the map as a separate series.

The topography varies from gently to strongly undulating. The stronger relief usually occurs where the shingle beaches have been formed on com-

paratively steep, rocky slopes. If these slopes are long, a series of strands may occur at various levels formed at different stages of the marine sea. The natural drainage is excessive.

The natural vegetation on these ridges is chiefly hardwoods with a sprinkling of conifers.

The soil profile under natural conditions consists of a shallow A_1, in which organic and mineral material are well incorporated. Below this, and grading into the parent material, are layers varying from light to moderate yellow-brown. A light yellow-brown horizon may occur just beneath the A_1, indicating some leaching, but this is usually very faint. Commonly the moderately dark, yellow-brown layer is the dominant horizon and grades through the light brown to the underlying parent material.

The cultivated surface soil is a stony sand, sandy loam or loam. Though the organic matter content is comparatively low under natural conditions, it is built up on many farms. This occurs where the remainder of the farm is of the shallower Farmington types, the farmer preferring to apply the manure on the deeper shingly soils.

Utilization

The Farmington shingly loam is quite extensively used for a combination economy of mixed farming and grazing. There are very few farms located entirely on this type. Generally shallower Farmington types also occur. Most of the cultivated crops required for the household and for the stock are grown on the shingly sandy loam. The remainder of the farm is usually in pasture and woodlot.

Although a droughty soil, low in most plant nutrients, fair crops are grown in favourable seasons where the land is heavily manured and fertilized. Although stones are numerous, they are not sufficiently so to require removal. They do, however, give the farmer considerable concern during the farming operations.

Farmington Sandy Loam (13,400 acres)

The Farmington sandy loam is developed on slightly undulating sandy materials of varying depths up to ten feet over limestone bedrock. In general, the depth ranges from three to six feet. The origin of the sandy materials over the limestone bedrock is variable. Although most of these materials are somewhat stony, owing to the shallow covering over the bedrock, they may be grouped into three classes according to the number and type of stones. In certain sections, such as the western portion of Goulbourn, the thin soil mantle contains angular stones such as are found in till so that the materials are similar to those of the Grenville sandy loam. In other sections more rounded cobbles or gravel occur and the materials resemble the Kars gravelly sandy loam. In still other sections the materials are deltaic, similar to those of the Rubicon except that, at frequent intervals, stones occur which have become separated from the underlying bedrock.

The topography is usually quite smooth although undulations occur due to irregularities in the underlying bedrock or as ridges in the drift. The drain-

age is variable. Imperfect to poor drainage occurs where the water table is held up by the rock strata. Frequently the water table is high for only part of the year, and in dry seasons these areas are as droughty as any others for these coarse materials tend to be droughty under any condition, a characteristic which is merely accentuated by shallowness over bedrock. Further, in order that the influence of the bedrock be reduced to insignificance there must be a considerably greater depth of these materials than is required if the materials are loams or clays. The drainage is commonly either excessive or imperfect, the latter being a seasonal condition.

The profile on excessively drained areas is similar to that of the shingly sandy loam. The cultivated surface soil, too, is similar except that stones are less frequent. In the imperfectly drained locations, the organic matter content of the surface is somewhat higher naturally, but is soon reduced under cultivation unless this is prevented by careful management.

Utilization

The Farmington sandy loam is most commonly used for a combination of general farming, pasturing and timbering. Most of the farmers derive a considerable proportion of their revenue from the pastures and woodlots. Chemical tests indicate a fair to low supply of plant nutrients. Moisture control is the chief production problem in these soils.

Farmington Loam (19,900 acres)

Description

The Farmington loam, as mapped in Carleton County, is a comparatively shallow loam soil over limestone bedrock with excessive to imperfect drainage.

Its profile is variable. The shallower soils have a thin surface layer underlain by a moderate yellow-brown horizon with little indication of leaching. As the depth of soil increases, a leached layer appears, and under favourable conditions a profile develops which is normal for the grey-brown podsolic region. Under imperfect drainage conditions, profiles resembling the Osgoode loam occur.

Utilization

The Farmington loam in Carleton County is used for general farming, with dairying and stock-raising playing a major role. The crops are fair in normal seasons and usually good in wet seasons. The average production is considerably reduced by dry weather.

The available plant nutrients, according to chemical tests, are approximately medium but their availability to plants depends on soil moisture conditions. However, under good management, loam soils which have at least two feet of drift over the bedrock produce fair crops except in dry or extremely wet years.

Farmington Clay Loam (3,500 acres)

The Farmington clay loam was mapped where one to six feet of grey-brown acid clay is found covering limestone bedrock.

The topography is commonly smooth and the drainage imperfect. The profile is somewhat similar to that of the Rideau clay.

Except for a higher lime content in some sections with a corresponding improvement in structure this soil has much the same possibilities as the Rideau. In general the heavier texture makes the Farmington clay loam more productive than the loam, but in dry seasons the imperviousness of the clay combined with its shallowness tends to make for a droughty condition.

D—2. Shallow Drift over Sandstone Bedrock, Usually Containing Large Proportions of Siliceous Materials

The Nepean sand is the complex mapped on shallow drift over sandstone bedrock. It has many characteristics similar to the shallow Farmington soils but is generally medium acid in reaction.

Nepean Sand (8,000 acres)

Description

The Nepean sand is a complex of soils developed on shallow drift over sandstone bedrock and occurs in Nepean and Huntley Townships. The topography is usually broken by rocky slopes although level upland areas are fairly general. The drainage is commonly excessive. The natural vegetation on the sandstone plains is dominated by red and Jack pine; birch and aspen are also common. Frequently the profile is practically featureless, with only a shallow grey-brown organic layer overlying the yellow-brown sandy parent materials. In the deeper soils a greyish leached layer may occur.

Utilization

The Nepean sand is used for grazing and timbering in much the same way as the shallow Farmington. General farming is not practiced as extensively as on the limestone plains. It would appear that these lands are about equally as good for grazing purposes as the Farmington.

D—3. Shallow Drift over Precambrian Limestone and Other Non-acidic Rocks, Usually Containing a Fair Proportion of Non-acidic Materials

The rough, rocky lands associated with Precambrian rock knobs have been roughly divided into two groups depending on the lime content. While this, in either case, is quite low, the soils derived from the so-called basic rocks, such as Precambrian limestone, basalt, etc., are less acid than those derived from the granitic rocks (granites, gneisses, etc.). While the overlying drift may have little relation to the underlying bedrock, it frequently happens that where the drift is shallow there is likely to be a closer correlation between the bedrock and the drift. The areas which are underlain by crystalline limestone have been mapped as *Chandos*. In some cases the thin drift may be composed of more acid materials, but in general the materials of the Chandos have a fair supply of carbonates. Areas where the shallow materials are underlain by the more acidic bedrock and generally composed of more acid drift have been designated as *Anstruther* and described in D4.

Chandos Sand (5,400 acres)

The Chandos is a complex of shallow soils over basic Precambrian rock. The materials in the areas mapped in the county are generally sandy with a fair supply of lime.

The topography is gently undulating. In general, the drainage is excessive, the water moving through the sand until it strikes the rock surface. Under forest cover the movement of water is controlled. When the forests are cut off, the moisture-retaining power of the soils is decreased; the movement of the water becomes more rapid and erosion becomes common.

The soil profile which has developed over much of the area is simply a grey-brown layer containing a fair amount of organic matter over the rocky soil materials.

Utilization

Very little of this soil complex is under cultivation and only a small proportion of it is being grazed. While most of the timber has been removed at one time, there are several bush lots containing good stands of timber. Scrub, however, is common over most of the area.

D—4. Soils Developed on Shallow Drift over Precambrian Granite and Gneiss

Anstruther Sand (16,600 acres)

The Anstruther is a complex of shallow acid soils over Precambrian granite and gneisses. As many of these rocks were covered by marine waters, they have been washed bare of the usual sandy drift. In some of the rocky hollows there are shallow deposits of marine clays. Shallow clays are not a characteristic of the Anstruther previously mapped in other counties. In certain sections of the Carleton County area there are shallow sandy soils which have not been greatly modified by the marine water and which are more typical of the Anstruther.

Utilization

Local clay areas afford some pasturage to stock. In general, the deeper soil areas are best suited to forestry. Much of the scrub on the shallow rock knobs will never reach a merchantable size but provide, in a limited way, food and shelter for wild life.

E. Soils Developed from Eroded Sand

Areas of drifting sand have been divided into two types. Sections of the Uplands and the Rubicon sand areas which have been recently eroded by wind are designated as Bridgman sand. Dune sand areas recently formed along the Ottawa River have been differentiated as Eastport. On most of these areas the sand has not been stabilized for a period sufficiently long to develop a true soil profile; hence they are more properly referred to as areas of soil materials rather than of soils.

Bridgman Sand (300 acres)

Description

The Bridgman sand consists of blow-out spots in the Uplands and Rubicon sand areas. The two largest areas occur near Merivale and the Uplands airport in the vicinity of the city of Ottawa. The estimated area of 300 acres does not include areas too small to show separately on the map.

The areas from which the sand has been removed are light in colour, neutral to slightly acid in reaction, with a very thin layer of organic accumulation. The areas which have received an accumulation of drift sand may present the same appearance on the surface but, underlying these geological sands, there frequently occurs one or more buried surface layers somewhat higher in organic matter.

Utilization

In order to protect adjoining lands these areas should be reforested.

Eastport Sand (1,600 acres)

Description

The Eastport sand is a land type comprised of shifting sand dunes and associated marshy and poorly drained sand areas. A single area occurs near Constance Bay. There is practically no profile development. When stabilized with vegetation a shallow organic layer forms. In time this may be covered by drifting sand. This process may be repeated a number of times until several surface layers become buried. These buried organic layers perform some slight function in holding moisture. Areas where they occur are more easily reforested than those locations where the geological materials come to the surface without an organic layer of any kind.

Utilization

Drifting sand dunes should be reforested to protect adjoining lands. As this type occurs along the shore of a lake or river commonly in association with a sandy beach, it is frequently used as a site for camps and summer cottages.

F. Soils Developed on Flood Lands along Stream Courses

Bottom Land (7,100 acres)

This land lying along stream courses, and subject to flooding, is designated as Bottom Land. Except in local areas along the larger rivers this flood land is quite narrow. It frequently happens that in order to recognize flood lands a wider strip with included eroded stream banks, etc., is indicated on the map. There are usually successive layers of alluvial silt, fine sand, and clay intermixed with layers of organic matter.

Utilization

Grazing is the chief agronomic use of these flood lands. In a regional conservation plan many of the flood plains and the eroded banks should be reforested while others should be cleared of brush and trees and kept in grass to provide for free movement of water at flood time.

G. Soils Developed on Organic Materials

In areas where the drainage is very slow, or where it may become impounded in shallow depressions, the organic remains of trees, shrubs, herbs and mosses tend to accumulate. Where this organic matter is largely decomposed and mixes readily with mineral material the layer of accumulation is known as muck. The peats are comprised largely of slightly decomposed moss and woody materials. While there are few bogs which can be accurately classified either as peats or mucks, those associated with the acid mineral materials are predominantly peat while those found in the limier depressions are generally mucks.

Muck (55,400 acres)

Description

Muck is widely distributed throughout Carleton County. The topography is commonly level or slightly depressional. The drainage ranges from very poor to ponded, much of the land being subject to flooding.

The vegetation is variable, but in general it consists of elm, ash, white cedar and balsam. Sedges are common herbaceous plants.

The following was a common arrangement in the few muck profiles examined. The surface consists of a fibrous surface layer largely of sedge origin. This is underlain by a woody layer. The third organic layer is a sticky well-decomposed black muck. This layer usually rests upon blue-grey mineral material. There are, however, large tracts in Marlborough Township and elsewhere associated with the Farmington soils in which the muck is underlain by limestone bedrock.

Local shallow areas too small to indicate on the map are common inclusions with the Chandos and Anstruther. Shallow muck areas over clay have been separated on the map as North Gower clay loam–shallow muck phase.

Utilization

Comparatively small areas of muck in the Cyrville district near Ottawa are used for truck crops. With the exception of the shallow deposits over clay there is very little muck used for general farm crops. Most areas support a forest or scrub vegetation. It is important that these should continue to do so, particularly the shallower ones.

Peat (5,100 acres)

Practically all of the peat mapped in the county lies in the Mer Bleue Bog east of Ottawa City. This is largely an area where the materials are slightly decomposed fibrous peat, largely of moss origin. The vegetation consists of sphagnum moss, many heath plants and scrubby spruce and tamarack. On a detailed survey, portions around the fringes of this bog may be classified as muck.

Utilization

Of little value for general farm and forest crops the most extensive use of peat lands would appear to be that of a water reservoir. They also serve to feed and shelter wild life to a limited degree. A portion may be developed for specialized crops such as cranberries.

PART IV

AGRICULTURE

Early Settlement and Agricultural Development

Lumbering was an early and thriving industry in Carleton County. As early as 1806 it is reported that lumber was taken down the Ottawa River by raft to Quebec. The lumber trade increased rapidly once a market was located in the United Kingdom for the white pine and oak of the Ottawa Valley. By 1809 the timber trade had developed to the extent that, for the first time in her history, Canada enjoyed a favourable balance of trade. The increased importance of the trade resulted in thousands being sent to the bush to cut timber and drive the rafts to Quebec. Timber limits were sold at auction at about a dollar or a dollar and a half a square mile. The lease holder had cutting rights only and the land belonged to the Crown. The lumber camps formed a ready market for the agricultural products. Many worked in the lumber mills in the winter and returned to till the land during the summer months.

After the construction of the Rideau canal most of the trade of Upper and Lower Canada went past Bytown (Ottawa). In 1855, Ottawa was incorporated as a city. The first white inhabitant reported in Gloucester Township was in the year 1803. According to "A Report of Ontario from the Agricultural Commission of 1881," settlement began in Nepean Township in 1810 and by the year 1881 the whole township was settled. Settlement began in Osgoode Township in 1827 and by 1881 seven-eighths of the township was occupied.

Early farming was largely of a self-sufficing type. Farmers cleared a plot large enough to supply grain for themselves and their livestock. The crops grown during the pioneer days were chiefly small grains and hay.

The Report of the Agricultural Commission for 1881 states that although the importance of underdraining was generally recognized little had been done. Very few artificial fertilizers were used, although the farmers in the immediate vicinity of Ottawa drew large quantities of manure from the city. American buyers frequented the Ottawa market to purchase horses, and it was not uncommon for the surplus stock to be taken to the States. Three cheese factories were operating in 1881. In addition, the county contained large sawmills, flour mills, woollen factories, foundries, machine shops, numerous lime kilns and brick yards. After the land was cleared, agriculture expanded till it became the most important industry of the county.

Present Agriculture

The extensive use of Carleton County lands for agriculture and associated grazing and forestry purposes is indicated in the following table. Over 80 per cent of the occupied land is devoted to cultivated crops or natural pastures. A large proportion of the remainder is composed of forested areas from which the farmers derive a supplementary income.

TABLE 8

PRESENT LAND USE (1931 CENSUS)

	Acres	Per Cent of Total
A.		
Total Land Area	606,080	100.0
Occupied Land	523,742	86.4
Improved Cleared Land	325,299	53.6
Unimproved Occupied Land	198,443	32.7
Including:		
Natural Pasture	106,262	
Wooded	65,957	
Marsh or Waste Land	26,224	
B.		
No. of Farms	4,363	
Average Acres per Farm	120	
Average Improved, Cleared Land per Farm.	74.6	

From the above figures it will be noted that the average size of farm in Carleton County is 120 acres, of which almost seventy-five acres are cultivated for the growing of general farm crops. The average size of the wooded land is approximately fifteen acres per farm.

TABLE 9

ACREAGE AND DISTRIBUTION OF CROPS IN CARLETON COUNTY (1931 CENSUS)

Wheat—Spring	4,020
Barley	7,807
Oats	71,434
Rye	189
Corn for Fodder	11,743
Buckwheat	4,897
Mixed Grain	17,613
Cultivated Hay	109,453
Timothy	7,528
Alfalfa	3,524
Sweet Clover	1,277
Potatoes	5,578
Turnips and Swede	709
Mangolds and Sugar Beets for Feed	308

A glance at Table 9 indicates that the majority of the cultivated land is utilized for the growing of cereal grains and cultivated hay. Grass seed is grown in the Carp Valley with considerable success. Although many of the soils are adapted to growing alfalfa, the crop occupies only a very small acreage. Only a few use alfalfa in their grass seed mixture.

The dairy industry is well developed in the county. Several fine herds of Holsteins are found in Nepean, North Gower and Osgoode Townships. Many farmers enjoy the advantage of being close to the large urban centre of Ottawa and are able to make use of its fluid milk market. Most of the 600 city milk shippers are located in Nepean and Gloucester Townships. Thirty-eight cheese factories operate in the county. In 1930 the value of milk produced on Carleton County farms exceeded $2,050,000.

Mixed farming is the dominant agricultural occupation in the northwestern section of the county. Production of beef cattle, hogs, poultry, cereal grains and grass seed form the basis from which the farm income is derived. The growing of registered seed began to reach important proportions about 1928

and at the present time is an important cash crop. Most of this is produced in the Carp Valley with lesser amounts along the Rideau River, and in Nepean Township.

Vegetables are grown on a commercial scale in Gloucester Township adjacent to the city of Ottawa. Potatoes, sweet corn and turnips are important cash crops. According to Table 9, slightly over 5,500 acres were planted to potatoes, and for the most part these were located on the lighter textured soils of the county.

The flax industry has developed since the outbreak of the war in 1939. It was first established in the Richmond district with growers in Gloucester, Nepean, North Gower and Marlborough Townships. More recently it has spread to Fitzroy and Huntley Townships.

The Utilization and Management of Carleton County Soils

The use of land is determined, in large part, by its physical characteristics. To carry on a profitable agriculture, the system of farming must be adapted to these characteristics. They determine, in large part, the rate at which nutrients may be obtained by plants. Some of these physical factors, such as topography, texture, depth to bedrock, etc., a farmer does not attempt to change but plans his type of agriculture to fit the condition as it exists. Other factors such as structure, moisture-holding capacity, stoniness, etc., a farmer can modify so as to increase the productivity of the soil. A knowledge of all these factors is essential to maintain the soil in the best physical state, to obtain the optimum results in the production of crops, and to determine the types of agriculture which can best be practiced under a given set of economic conditions.

Many of the relationships between the characteristics of Carleton County soils and crop production require detailed studies which cannot be made during the initial work of classifying soils. However, the following discussions, based on generalizations made during the progress of the survey, are presented in the hope that, though preliminary and incomplete, they may prove helpful.

Since soil texture is widely recognized as a factor influencing utilization and management, the soils developed on the deeper mineral deposits have been arbitrarily placed into heavy, intermediate and light textured groups. In so far as possible, the heavy textured group includes the clays, silty clays and clay loams, the intermediate textured group includes loams, silt loams and sandy loams, and the light textured group is comprised of the sands. There are soil types or complexes having a wide range of texture which must, of necessity, be grouped on an arbitrary basis, for example the sand-spot phases of the Rideau and the Bearbrook are discussed with the heavy textured soils although the surface soil ranges from a sand to a heavy clay. The fourth group includes the shallow soils over bedrock, and the fifth group is comprised of organic soils and other lands subject to flooding.

Heavy Textured Soils

The series discussed under this heading are Rideau, Renfrew, Ellwood, Bearbrook, Carp and North Gower. The first four, namely, the Rideau, the

Renfrew, the Ellwood and the Bearbrook are slightly to medium acid while the Carp and North Gower are neutral to slightly alkaline. Organic matter does not so readily incorporate with the more acid clays; neither is a good structure so easily maintained. These characteristics, associated with a lower lime content, have such a pronounced influence on the utilization and management of clays that it has been necessary to consider two distinct subgroups in portions of the following discussion. Deep, heavy soils occupy approximately 27.4 per cent of the total mapped area in the county, of which 10.3 per cent are of the more acid type and 17.0 per cent are less acid.

The fineness of particles in clay soils retards the movement of air and water and they readily become water-logged. In time of drought they may not sufficiently supply the plant with water. Temperature changes slowly in clays and consequently they are late soils. They shrink upon drying, forming large gaping cracks, causing much damage to plant roots. Heavy soils have a high water-holding capacity. They are plastic and adhesive when wet and tend to form clods when dry. They are usually well supplied with plant nutrients, particularly potash. Clay particles play an important part in the process of making nutrients available to the plants. The undesirable physical properties which make heavy soils difficult to work frequently prevents their most profitable utilization.

Drainage of heavy soils is of prime importance. The external drainage of the Carleton County clays varies from moderate to poor. The internal movement of water is very slow on account of the comparatively impervious subsoil even on those areas with a low water table. Every practical means should be taken to improve the drainage. The land should be plowed in narrow strips, leaving dead furrows from one to two rods apart. Tile drainage should prove useful, although a comparatively small acreage of these soils are tile-drained at present. Internal drainage is improved by maintenance of good tilth.

On the heavy acid soils of the Rideau, Renfrew, Ellwood and Bearbrook series good tilth is difficult to maintain. They tend to puddle when wet and bake easily when dry on account of their slow drainage, acid reaction and low organic matter content. The bad effect of plowing when too wet can be seen not only for one season but many years. On the more sloping areas, sheet erosion removes the surface layers adding to the difficulty of maintaining a friable surface soil. Lime should give beneficial results on Renfrew, Ellwood, Bearbrook and the lighter spots of the Rideau. Liming may also improve the Rideau clay, particularly if difficulty is experienced in obtaining a catch of clover. The importance of increasing the organic matter content of these soils is evident so that the application of farmyard manure and the plowing down of green manures would appear to be basic procedures in their management. Alfalfa or other legumes can be successfully grown by draining and liming where necessary. On these heavy acid clays applications of nitrogen appear to give results even where the organic matter is comparatively high. This is particularly true in the production of grain crops. There is less need for phosphorus and potassium on the clays. The lighter sand spots and the eroded areas have a greater requirement for commercial fertilizers.

The heavy acid clays suffer more from water erosion than any other group in the county. They have developed on clay plains which have been dissected

by streams to form an undulating terrain. Control measures should be adapted to prevent gullying by accelerated erosion. Drainageways should be kept in sod. For the deeper and more active gullies, control measures would include diversion of the stream, sodding, planting to erosion-resistant plants and the building of various forms of dams, depending on local requirements.

The sand-spot phase of the Rideau and Bearbrook clays presents additional problems in farm management owing to two soils of widely differing textures occurring in the same field. The clay portions could be treated similarly to the Rideau or Bearbrook clay. The upper layers of sand drain readily, but the underlying impervious clay layer holds up the water table resulting in a cold, late soil. These sand knolls require organic matter and lime to even a greater degree than the clays, and fertilizer supplements are more commonly required on account of the much lower fertility levels.

In common with all heavy soils the main requirement of the neutral clays of the Carp and North Gower series is improved drainage. The need, of course, is greater on the North Gower than on the Carp on account of the higher water table in the former. The internal drainage in both of these series (with the exception of the shallow muck phase) is commonly better than in the more acid soils, owing to the better structure of the surface soils and a seemingly more pervious subsoil. Fairly good crops can be raised under a good system of surface drainage. Liming and commercial fertilizers are not generally required. These soils are well supplied with organic matter, and with reasonable care in their management no special provisions for supplying these constituents will be necessary for a long time. However, the maintenance of the present supply of organic matter cannot be too strongly emphasized in view of what has happened in other parts of Ontario. The loss of organic matter and its associated structure in a good clay loam may result in what is locally called a poor clay. Strictly speaking, however, the difference is dependent on structure and is not one of texture. The reaction and present organic matter supply favours a good tilth. The common rotation is hay, pasture and grain, roots and potatoes being grown to a limited extent. Alfalfa is a common crop on the Carp but is not grown on the North Gower except where the drainage has been much improved as by tiling.

The clearing and farm management of the shallow muck phase of North Gower clay loam present many problems. If the muck is too severely burned, the grey clay layer (very deficient in organic matter) becomes the surface soil. Without organic matter well incorporated with it, this layer is difficult to handle, is poorly aerated and does not contain a sufficient supply of available nutrients. If too much muck is left, it forms unproductive areas in an otherwise productive soil for the nutrient levels of the muck are low. The muck is a late soil in the spring and dries out rapidly in the summer. It is necessary to leave an optimum amount of muck to be incorporated with the grey mineral layer, so that a combination of the two will constitute the cultivated soil. This can be accomplished by burning when the water table is at a desirable level. The skilful blending of muck and mineral matter to form a productive soil requires time and experience on the part of the operator. The nutrient levels of the underlying clay are medium to high but are available to the plants only under a favourable physical condition. This can be produced by

the addition of humus which may be supplied either in the form of muck, farmyard manure or plant residue. The muck being available in sufficient quantities is the most economic source. The organic matter in manure and plant residue is more active but usually requires too long a period to build up the fertility with these materials alone.

Under good management the heavy soils of Carleton County are suited to a great variety of crops, particularly small grains, hay and pasture. That wheat, commonly well adapted to most heavy soils, is not extensively grown in the county would indicate limitations established by climatic or other factors. The clay areas in the northwest of the county (Renfrew clay) produce good crops of field peas. Alfalfa grows well wherever the drainage is favourable. Hoed crops such as corn and roots are grown locally in the dairying sections. Their more common inclusion in the rotation is suggested.

Sands

Sands occupy approximately 10.7 per cent of the soil area in the county. Included in this group are three soil series, the excessively drained Uplands, the Rubicon which has intermediate drainage and the poorly drained Granby. Included with these are two land types in which the soil materials are sand but which are seldom stabilized long enough to have any depth of soil developed upon them. These areas of drifting sand are Bridgman and Eastport.

The coarseness of particles and consequent large pore space permits of easy movement of water in sands. Owing to the absence of fine material they have little power of retaining water and comparatively few facilities to provide for the mechanism of plant nutrition. Sandy soils tend to be dry, loose and low in soluble substances. Their utilization is influenced largely by the supply of moisture available to the growing plants, a factor largely conditioned by the organic matter content and by the position of the water table. Many of the sands are underlain by less pervious till or clay which assist in maintaining the moisture at a level which the plant roots can reach. Many specialized crops can be profitably grown on light textured soils because the returns from these permit a more intensive soil maintenance programme.

The removal of excess water is a problem on these soils only where the water table is high, as in the Granby and in the poorly drained sections of the Rubicon. While the removal of excess water is important on the poorly drained areas it is also important to lower the water table no farther than is necessary. Once drained, the content of organic matter in a sandy soil is the chief means of moisture retention. The poorly drained areas commonly have a higher content of organic matter, but upon draining and cultivation this rapidly dwindles unless precautions are taken to prevent it. With a low water table and a low content of organic matter, the problem of water retention on the low spots of the Rubicon becomes more nearly comparable to the areas of good natural drainage. To increase the organic matter content and to maintain it at a satisfactory level in the Uplands is generally not economical except for specialized crops, or in places where it occurs in small areas associated with better soils on the same farm.

The problem of obtaining good structure in sands is different to that of clays. In sands the objective is to secure cohesion of the particles to prevent

drifting and to retard water from moving too freely. In this, organic matter plays the important role of binding the single-grained particles together. The problem is most acute on the Uplands and on the Rubicon knolls. The cohesive structure desirable in light soils is naturally present in the poorly drained areas as long as the soil is poorly drained. Upon drainage, however, this cohesion disappears with the decrease in organic matter.

Lime should give beneficial results on both Uplands and Rubicon, with the possible exception of the poorly drained sections of the latter. The plowing down of green manure to supplement farmyard manure is recommended. With the use of lime and commercial fertilizers, alfalfa and other legumes may be grown except on the extremely dry or wet areas. Nitrogen is one of the main requirements and seems to give particularly good response when applied to grain crops.

While under natural conditions the fertility levels of Granby sand are fair, these cannot be maintained under cultivation except through careful management. The importance of maintaining the organic matter content at the level existing under natural conditions cannot be overemphasized. Liming is not generally required.

This group suffers little from water erosion but is subject to wind erosion. Blow-out spots are common on the Uplands and Rubicon soils.

Grain and hay crops are usually poor on the Uplands and poor to fair on the Rubicon. Fair crops of potatoes are grown. There does not appear to be a common rotation. In fact, many farmers do not follow any particular rotation, because of the uncertainty of getting a catch of grass. Where the Granby sand has been improved by drainage the crops grown are similar to the Rubicon but often more uniform. The common crops where drainage is more restricted are alsike, timothy and buckwheat. Pastures and woodlots are common.

Loams, Silt Loams and Sandy Loams

Loams, silt loams and sandy loams occupy 21.8 per cent of the soil area of the county. These may be roughly divided into two groups: those which are stone-free and those which contain stones. The stony series are Grenville, Lyons, Galesburg, Leitrim and Kars. The stone-free loam series are the Osgoode and the Castor which differ chiefly in their lime content. The Castor generally contains more silt than the Osgoode. There are three other series of stone-free soils in which the surface is generally a sandy loam but in which clay comes to the surface in parts of the area. The sand is seldom more than five or six feet in depth. These are the Manotick, the Allendale and the Granby sandy loam. The Manotick is better drained than the other two which differ from one another in lime content.

All of these soils have properties intermediate between the clays and the sands. They permit of the free movement of water yet have a better water-holding capacity than the sands. They show less tendency than clays to become water logged and to allow plants to become parched in dry weather. They are also intermediate in their ability to supply available plant nutrients. They are adapted to a wider variety of crops than either the clays or the sands. The

cost of maintaining their fertility is higher than in the clays, but often this is more than counterbalanced by their more tractable physical qualities.

On most of the *stony loams and sandy loams* (Grenville, Galesburg, Leitrim and Kars) the problem is not one of removing excess water but of retaining some of that which passes through the soil. This is more easily accomplished in this group than in the excessively drained areas of Uplands sand. While there are times in which most areas of Grenville loam become droughty, its water-retaining capacity is better than most soils in this group. The Lyons is poorly drained but is frequently so stony that it seldom pays to both drain and pick the stones. Stoniness also limits the usefulness of the bouldery phase of the Grenville.

The necessity of obtaining cohesion of the particles is also important, but again this is more easily obtained than in the Rubicon or Uplands. Being accomplished largely through the increase of organic matter, this is indirectly dependent on the lime content and the moisture-holding capacity of these soils. It is doubtful if lime will give results on any except the Leitrim. Commercial fertilizers will increase production but may not do so economically. Nitrogen is one of the main fertility needs, particularly on grain. The plowing down of green manures to supplement farmyard manure is recommended. Alfalfa and other legumes can be successfully grown.

In general these types suffer little from erosion. There are, however, some steeper slopes particularly in the Grenville loam where much topsoil is lost by sheet erosion. The crop rotation on these types includes hay, pasture, small grains and often corn and roots. Potatoes are grown extensively on many sections of the Kars. Dairying, with specialization in cheese, is common.

Improved drainage is required on the *stone-free soils of intermediate texture* with the exception of portions of the Manotick sandy loam. The pervious stone-free materials of the Osgoode and Castor facilitate artificial drainage. This is more difficult to accomplish in the Allendale and in portions of the Manotick and Granby because of the clay subsoil which underlies the sandy loam. In some cases a hardpan forms at the junction of the sand and clay.

The organic matter content under natural conditions is usually satisfactory for the maintenance of a good tilth. It must be remembered that upon drainage and cultivation the levels of organic matter will lower quickly in a loam soil to a point which will affect the fertility. As long as the soil contains a good level of active organic matter the nitrogen level will remain fairly satisfactory. Liming should give beneficial results on the Manotick, Allendale and Castor, particularly where failure to get a good catch of clover is experienced on well-drained soils.

The crop rotations on these types include hay, pasture and small grains. Under improved drainage conditions, corn and roots are grown generally. Potato growing is becoming general on the Castor silt loam wherever the drainage has been improved.

Shallow Soils over Bedrock

Shallow soils over bedrock occupy 28.5 per cent of the soil area in the county. These soils are mapped as Farmington, Nepean, Chandos and

Anstruther, depending upon whether the underlying rock is limestone, sandstone, basic Precambrian or acidic Precambrian. In the Chandos, Anstruther, Nepean and the undifferentiated areas of Farmington the bedrock is commonly very close to the surface, but in those portions of the Farmington area which have been designated by a type name such as Farmington loam, etc., the soil mantle is somewhat deeper. The deeper subgroup will be discussed first.

The soil materials of the Farmington shingly loam, Farmington sandy loam, Farmington loam, Farmington clay loam and Nepean sand are usually two feet or more over bedrock but not sufficiently deep to eliminate the effect of the bedrock on plant growth.

While, in wet seasons, the underlying bedrock in certain areas restricts the drainage of surplus water, the problem on most shallow soils is one of moisture retention rather than of drainage. Organic matter is the key to moisture retention. As much of this must be produced on the soil it is evident that the fertility can be built up only gradually and during favourable seasons. It would appear that these soils can be satisfactorily used only by a type of farming which gives sufficient returns to enable the farmer to carry on good management practices. This is the present situation on some of the deeper Farmington areas in Carleton County whose location enable them to take advantage of the Ottawa milk market.

Liming is seldom necessary except on the acid Nepean sand. Generally good tilth prevails and is further improved whenever there is an increase in the organic matter. The shallowness to bedrock increases the intractability of the clays, particularly those low in organic matter. The shallow acid grey-brown clays seem wetter in spring and fall and drier and more cracked in the summer than similar materials on the deeper Rideau soils. Clovers do well on the Farmington soils and an increase in their use is strongly recommended. They are not so well suited to the Nepean sand but will grow very well if lime and fertilizers are applied. Erosion is seldom a menace except on the steeper, shallower slopes.

In addition to clover, other hay and pasture crops do fairly well on these soils. Grain and corn are also grown. Owing to the uncertainty of weather conditions and for other reasons there seems to be no common rotation in use.

In the case of very shallow soils over bedrock such as are common over most of the Farmington (undifferentiated), Chandos and Anstruther areas, the land is submarginal for agriculture. Except for local pockets the Chandos and Anstruther are generally better utilized for forestal purposes than for agriculture. In some places the soil is too shallow for tree growth, but may provide food and shelter for wild life. Although these areas have a low productivity rating, they should be protected from fire as the removal of the vegetative cover induces erosion. In general these remarks apply also to the Farmington (undifferentiated) but on portions of this a profitable type of grazing has been carried on, and there are local pockets similar to the deeper Farmington types described above.

Organic Soils and Other Flood Lands

Occupying approximately 11.6 per cent of the soil area of the county are the organic soils, mucks and peats, and the flood lands along the stream

courses mapped as Bottom Land. Since a very small acreage of the organic soils in the county has been developed, only a brief discussion of developing and managing these soils is given here. If further information is required the reader is referred to the following sources.*

These and other publications outline the points to be considered in developing organic soils. Many of the Carleton County soils are too shallow to be utilized as muck soils. Where the underlying materials are clay, most of the muck may be removed by burning and a fairly productive mineral soil developed. But over much of the county the muck is shallow over bedrock, as in the southwestern sections of the county, or is underlain by coarse gravel and sand as in areas immediately adjacent to gravel ridges. In both of these cases it is better not to attempt to develop the muck as it will produce much better forest before than after the venture. In the Mer Bleue bog the organic matter is derived from sphagnum and is quite resistant to decomposition (peat). In the more southerly bogs there are large areas formed from the decomposition of wood and sedges. Crops planted in this type of organic soil (muck) respond much more rapidly than do those in the peat. There is the danger of rapid decomposition of the muck upon drainage so that in time the muck soil disappears. For this reason and also to maintain an adequate supply of water for the growing plant it is essential that the water level should be carefully controlled. Organic soils are generally low in all plant nutrients so that they require careful and expensive fertilization. The great cost of developing and maintaining production on these soils makes it necessary that they be used for the production of specialized crops yielding high returns.

Crop Adaptability and Productivity Ratings of the Soil Types†

In the foregoing discussions, the favourable and unfavourable features of each soil type has been presented in relation to crop production. The degree to which the undesirable features may be overcome has been discussed and some methods suggested. Reference has been made to the crops which appear to be best adapted to a specific soil. Much has yet to be ascertained about crop and soil relationships. It is hoped that research along these lines will provide specific data in terms of soil type and crop variety. In the meantime, certain generalizations can be made. These are presented in Table 10. It will be seen that while many soils are adapted to a range of crops, others are well suited for a comparatively few.

The ratings are based on the general productivity, workability and conservability of each soil in relation to the production of a specific crop. It is not enough to evaluate the internal features of the soil as a media in which the crop is grown. In addition, external factors must also be evaluated to ascertain the degree to which these affect the production of the crop by requiring special methods of cultivation and erosion control, etc., in order that the soil will not be unduly exploited. The internal features affecting the

*(a) McKibbin, R. B., and Stobbe, P.C. — Organic Soils of South Western Quebec— Pub. 499, Dom. Dept. of Agriculture.
(b) Publications of the New York State Agricultural Experimental Station, Geneva, N.Y.
(c) Publications of the Michigan Agricultural Experimental Station, East Lansing, Mich.

†NOTE.—These ratings have reference to average conditions over the entire soil type as mapped and do not necessarily apply to every individual farm.

growth of plants are mainly those concerned with the maintenance of an optimum supply of moisture and plant nutrients. These are: organic matter content, texture, structure, reserve supply of nutrients, and water, together with factors affecting their availability. The external factors affect plant growth less directly through their influence either on workability or on conservability. These factors affect tillage and other field operations and determine methods necessary to rehabilitate, maintain, or increase the productivity of the soil. Such external factors are topography, external drainage, stoniness and erodibility.

Actually the only absolute measure of crop adaptability under specific management conditions is average yields, with samples well distributed over the soil type area and covering a period of years sufficient to eliminate differences due to climate. Yield data on such a comprehensive scale are not available for Carleton County so it is necessary to arrive at an estimate by inductive reasoning. With a general knowledge of the soil requirements of certain crops, and of the degree to which a specific soil possesses such requirements, a theoretical rating can be obtained. Such ratings established for Carleton County soils have been checked by general observations made during the survey, by data and opinions of members of the Experimental Farms Service and by consultations with local farmers and others. The data in Table 10 is a summary of these ratings.

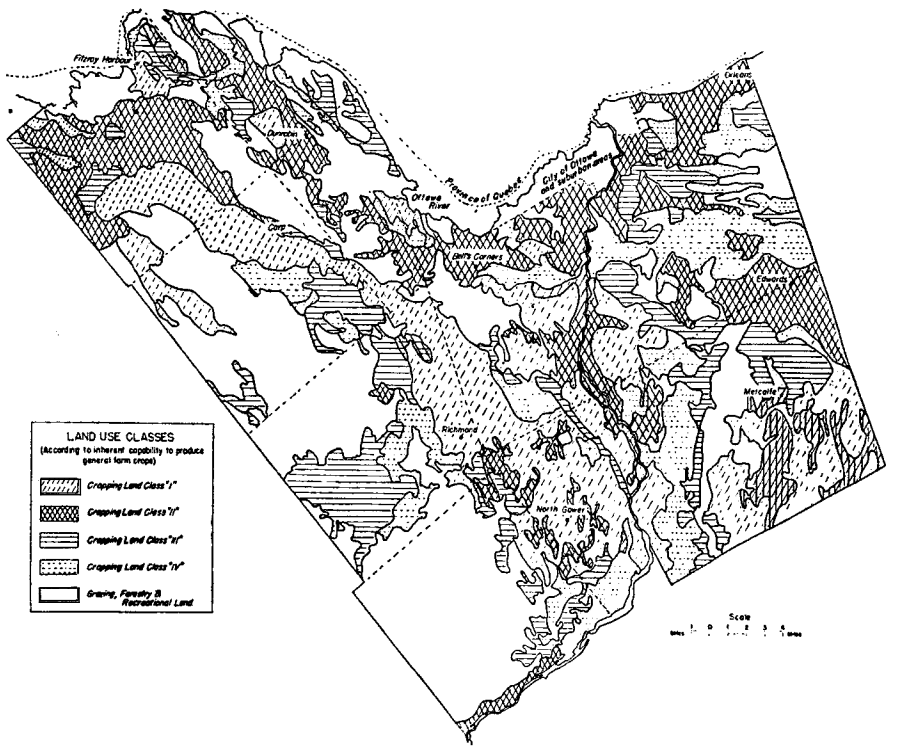


FIG. 14

TABLE 10

CAPABILITY RATINGS* OF CARLETON COUNTY SOILS FOR THE PRODUCTION OF GENERAL FARM CROPS

Soil	Oats	Barley	Alfalfa	Red Clover	Alsike	Timothy	Fodder Corn	Turnips	Potatoes	Mangolds	Permanent Past're	Comments on General Suitability
CLASS I—Good Crop Land.												
Carp Clay Loam	G	G	G	G	G	G	G–F	G–F	F–P	G	G	Well suited to intensive production of general farm crops.
Osgoode Loam	G	G	F	G–F	G	G	G–F	G–F	F	G	G	
North Gower Clay Loam	G	G	F–P	G–F	G	G	F–P	F–P	F–P	F	G	
CLASS II—Good to Fair Crop Land.												
Castor Silt Loam	G	G–F	F	F	G–F	G	G–F	G–F	G–F	F	G–F	Moderately to well suited to intensive production of general farm crops.
Grenville Loam	G–F	G–F	G–F	G–F	F	G–F	G–F	G–F	F	F	G–F	
Manotick Sandy Loam	G–F	F	G–F	F	F	G–F	G–F	G–F	G–P	F	F	
Rideau Clay (sand spot phase)	G–F	F	F	F	G–F	G–F	F–P	F–P	F–P	F–P	G–F	
Rideau Clay	G–F	F	G–F	F	G–F	G–F	P	P	P	F–P	G–F	
Ellwood Clay Loam	G–F	F	F	G–F	G–F	G	F–P	F–P	P	F–P	G–F	
North Gower Clay (shallow muck)	F	G–F	P	F–P	G–F	G	P	P	P	P	G–F	
Renfrew Clay	G–F	F–P	F	F	F	G–F	F–P	P	P	F–P	G–F	
CLASS III—Fair Crop Land.												
Galesburg Sandy Loam	F	F	G–F	F	F	G–F	G	G	G–F	F	G–F	Moderately suited to general farm crops. In some cases better suited to a combination of agriculture and grazing or forestry.
Farmington Loam	F	G–F	G–F	F	F–P	G–F	F	F–P	F	F–P	F	
Grenville Sandy Loam	F–P	F–P	G–F	F	F–P	F	G–F	G–F	G–F	F–P	F	
Bearbrook Clay	F	F–P	P	F	F	G–F	P	P	P	F–P	G–F	
Leitrim Gravelly Loam	F–P	F–P	G–F	F	F–P	F	F	G–F	G–F	F	F–P	
Granby Sandy Loam	F	F–P	P	F–P	F	G–F	F	F–P	F–P	F–P	F	
Allendale Sandy Loam	F	F–P	P	F–P	F	G–F	P	P	F–P	P	F	
Kars Gravelly Sandy Loam	P	F–P	F	F–P	F–P	F–P	G–F	F	G–F	F–P	F–P	
Rideau Clay (rock-knob phase)	F	F	F	F–P	P	F	P	P	P	P	G–F	

TABLE 10 (*Cont'd*)

CAPABILITY RATINGS* OF CARLETON COUNTY SOILS FOR THE PRODUCTION OF GENERAL FARM CROPS

Soil	Oats	Barley	Alfalfa	Red Clover	Alsike	Timothy	Fodder Corn	Turnips	Potatoes	Mangolds	Permanent Past're	Comments on General Suitability
CLASS IV—Fair to Poor Crop Land.												
Granby Sand	P	P	P	F-P	F	F	P	P	P	P	F-P	
Farmington Sandy Loam	P	F-P	F-P	F-P	F-P	F	F-P	F-P	F-P	P	F-P	
Farmington Clay Loam	F-P	F-P	F-P	F-P	F	F	P	P	P	F-P	F	Moderately to poorly suited to general farm crops. Often better suited to grazing and forestry.
Bearbrook Clay (sand spot phase)	F	F	P	F	F	F	P	P	P	P	F	
Renfrew Clay (compact subsoil phase)	P	P	P	P	F	F	P	P	P	P	F	
Rubicon Sand	P	P	P	P	F-P	F	F-P	P	F-P	P	F-P	
Lyons Loam	F-P	F-P	P	F-P	F-P	G-F	P	P	P	P	G-F	
Farmington Shingly Loam	P	F-P	F	F-P	P	F-P	F-P	P	P	P	P	
Grenville Loam (boulder phase)	P	P	P	F-P	P	F-P	P	P	P	P	F	
Uplands Sand	P	P	F-P	P	P	P	P	P	F-P	P	P	
CLASS V—Submarginal Crop Land.												
Muck	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	F-P	Very poorly suited for general farm crops. Generally better suited for grazing, forestry or recreation. Some of the soils (e.g. muck) are suited to a specialized agriculture on selected areas.
Bottom Land	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	F	
Farmington (undifferentiated)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	F-P	
Nepean Sand	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	F-P	
Anstruther Sand	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	P	
Chandos Sand	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	P	
Peat	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Bridgman	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Eastport	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	

*The soils are listed in order of general suitability under common practices within the county, such as (1) the improvement of drainage without the use of tile, (2) liberal use of barnyard manure, (3) only occasional use of commercial fertilizers except for potatoes, (4) moderate use of soil-building crops in the rotation, (5) limited use of lime. The crop adaptability rating for each soil type is indicated as follows: G = Good; G-F = Good to Fair; F = Fair; F-P = Fair to Poor; P = Poor.

While it may be readily understood that the ratings presented are averages, it may be well to mention that the variations within the type, as mapped, have a profound influence on the interpretation of these averages. For instance, the areas mapped as Carp clay loam possess a much greater degree of uniformity than the Manotick sandy loam. In the latter type the typical profile of sandy loam over clay occupies a comparatively small proportion of the area mapped, and there occur all the variations from profiles, practically all sand, to others practically all clay. In the Rubicon, a wide range of drainage and associated conditions prevail. Since these are complexes rather than types, their ratings might be better indicated as ranges rather than averages. However, adjustments can be made in the interpretation of the averages by an understanding of the range of characteristics of the mapping unit. The ratings are given for most of the general farm crops grown in the region. Some of these are not grown extensively on all types. For instance, there is little field data to support the ratings inductively obtained for such crops as alsike and mangolds.

Since management is an important factor affecting productivity, the ratings should be considered an average, representing crop response under the commonest practices of management in the district. This is based on a state of drainage improved only to the extent of that secured through open ditches, tile being very infrequently used. Commercial fertilizers are used on comparatively few farms, although the average amount used by these farmers (chiefly potato growers and dairymen) is comparatively high. Very little lime is used. Barnyard manure is applied to the fields in rotation, favouring the lighter soils where variations occur on the same farms.

Land Use Capability Classes

On the basis of their productivity, workability and conservability in relation to the production of general farm crops, the soils of Carleton County were grouped into five Land-Use Capability Classes. (See Table 10.) While these are more strictly comparable within the county, the soils of Class I compare favourably with most of the better soils of Southern Ontario under the same management. Because of poorer drainage they are not as naturally productive as a few of the rich undulating soils, such as the Newcastle loam. Nor have they the potentialities of the richest but poorly drained Clyde soils. These and a few others might be rated excellent to good crop land when compared to Class I of Carleton County. Again it may be well to emphasize that these are ratings based only on soil and other physical properties of land without regard to many economic factors such as distance to markets, etc.

The map (Figure 14) indicates in a general way the distribution of the land use capability classes. Owing to the broad scale of mapping and the generalization necessary to present such a map, it is evident that it should not be used for specific purposes such as farm by farm appraisals.

Land Use Capability Class No. 1

TABLE 11

SOIL TYPES COMMONLY OCCURRING IN LAND USE CAPABILITY CLASS NO. 1

	Acres	Per Cent of Total
Carp Clay Loam	28,100	4.8
Osgoode Loam	21,400	3.6
North Gower Clay Loam	63,000	10.7
	112,500	19.1

This group may be classified as good crop land since most of the soils in the group produce good yields of those farm crops generally grown in the district under the commonest practices of management. It has been necessary to improve the natural drainage except for small areas of the Carp. This improvement has consisted largely of open ditches, tile not having been generally installed. Once drained, the productivity of these soils is comparatively easy to maintain or to increase. They are not subject to erosion. Though some are clay loam in texture, they are not too difficult to work if the organic matter content is maintained. The Osgoode loam is more easily worked than the two clay loams but is lower in reserve nutrients. The natural fertility is medium to high. Liming is seldom necessary. All types are practically stone-free. They are particularly well suited to grain and grasses if the drainage has been adequately improved. Under the present economic conditions they appear to be best suited to an intensive development of mixed farming with a comparatively large proportion devoted to dairying and beef cattle. As these soils are seldom the only ones within a watershed, it would not seem imperative that any portion of their area be kept in forest as a means of water conservation when other less desirable agricultural lands could be utilized.

Compared with other soils in the county this group is capable of producing the greatest yields with the least expenditure for production and conservation.

Land Use Capability Class No. 2

TABLE 12

SOIL TYPES COMMONLY OCCURRING IN LAND USE CAPABILITY CLASS NO. 2

	Acres	Per Cent of Total
Castor Silt Loam	15,400	2.6
Grenville Loam	40,300	6.9
Manotick Sandy Loam	10,600	1.8
Rideau Clay, Sand-spot Phase	22,100	3.8
Rideau Clay	17,300	3.0
Ellwood Clay Loam	2,900	0.5
North Gower, Shallow-Muck Phase	9,300	1.6
Renfrew Clay	1,100	0.2
	119,000	20.4

This group may be classified as good to fair crop land since most of the soils of the group produce good to fair yields of the farm crops generally grown in the district under the commonest practices of management. These ratings

are on the basis of present state of drainage of the crop land of each type. Under the imperfect drainage conditions which naturally prevail on the Castor, this type would not rate as high as the Grenville with its generally good drainage. But under the current drainage conditions, open ditches on the Castor, no ditches on the Grenville, the Castor appears to be the more productive soil.

With the exception of the shallow muck phase of the North Gower and the Ellwood clay loam, this group of soils is more easily eroded than those of Class I and therefore require special management in certain areas. In general, the texture is a loam or heavier. Though the upper layer of the Manotick is a sandy loam the subsoil is usually heavy. In general, the clays are not as easily worked as those in Class I. Stones are a factor in the cultivation of the Grenville. The shallow muck is decidedly an unfavourable factor in the development and maintenance of productivity on that phase of the North Gower. In general, the nutrient levels of these soils are lower than in Class II or less easily available. Some, but not all the types are acid, requiring lime under certain conditions. With good management, including the use of fertilizers or other soil amendments to correct their deficiencies, these soils will produce good yields comparing favourably with those of Class No. 1, but with relatively higher expenditures for operating and conservation practices. In general, they are best suited to intensive development of general farming. There are a few areas, however, in each type where the best land use under the present economy would include a limited amount of reforestation.

Land Use Capability Class No. 3

TABLE 13

SOIL TYPES COMMONLY OCCURRING IN LAND USE CAPABILITY CLASS NO. 3

	Acreage	Per Cent of Total
Farmington Loam	19,900	3.4
Bearbrook Clay	2,900	0.5
Granby Sandy Loam	1,300	0.2
Galesburg Sandy Loam	4,500	0.8
Grenville Sandy Loam	1,300	0.2
Leitrim Gravelly Loam	1,900	0.3
Kars Gravelly, Sandy Loam	22,400	3.9
Allendale Sandy Loam	2,900	0.5
Rideau Clay, Rock-Knob Phase	10,200	1.7
	67,300	11.5

This group of soils may be classified as fair crop land since most of them produce fair yields. Even with the best management economically possible, they are not capable of producing as high yields of general farm crops as those grown on Land Class I under the practices common at the present time. This means that there is at least one characteristic limiting production which cannot be adequately overcome by good management under the present economic conditions. In the case of the Farmington loam this factor is the nearness to the bedrock accompanied by a comparatively light open soil. Shallowness is also a limiting factor in the Rideau clay, rock-knob phase. The impermeable subsoils of the Bearbrook, Rideau and Allendale restrict

drainage even where open ditches are in operation. The lightness and openness of the subsoil is the dominant limiting factor in the remaining soils. Most of these are a sandy loam or lighter in texture. In addition, they are generally either gravelly or stony.

In general, then, these soils have a lower productivity than those of Classes I and II. Most of them are not as easily worked as those of Land Class I. In the case of the clays there is a poorer structure. A mixed condition of sand and poorly drained clay as in the case of the Allendale increases the difficulties of management. The stones and cobbles of the Farmington, Galesburg, Grenville, Leitrim and Kars interfere with cultivation although they, by no means, inhibit it. The problems of erosion are no greater on these soils than on those of Class II.

Land Use Capability Class No. 4

TABLE 14

SOIL TYPES COMMONLY OCCURRING IN LAND USE CAPABILITY CLASS NO. 4

	Area	Per Cent of Total
Granby Sand	12,500	2.1
Farmington Sandy Loam	13,400	2.3
Farmington Clay Loam	3,500	0.6
Bearbrook Clay, Sand-Spot Phase	2,600	0.4
Renfrew Clay, Compact Subsoil Phase	1,100	0.2
Rubicon Sand	35,200*	6.0
Lyons Loam	4,500	0.8
Farmington Shingly Loam	9,900	1.7
Grenville Loam, Boulder Phase	1,900	0.3
Uplands Sand	13,100	2.2
	97,700	16.6

*There are several thousand acres of a smooth phase of Rubicon sand, mostly in Osgoode Township, which should be rated in Class 3, but was not separated on the map.

This grouping may be classified as fair to poor crop land. They possess definite detrimental features which limit their use capability and complicate the management requirements of these soils. The lighter soils are more open than those of Land Class III. The shallow soils are not as retentive of moisture. The poorly drained soils have some additional unfavourable features such as stoniness, poverty of nutrients or poor textural combination which increases cost of cultivation. Control of erosion is not a serious problem except in the case of the Uplands and some areas of Rubicon which have a strong tendency to blow unless well managed.

Although these are only moderately to poorly suited to general farm crops, the growing of such crops under the best possible management is frequently the most suitable land use. In many other cases, however, a combination of agriculture, grazing and forestry would appear to be the best way to fully utilize the potentialities of these lands at the present time.

Land Use Capability Class No. 5

TABLE 15

SOIL TYPES COMMONLY OCCURRING IN LAND USE CAPABILITY CLASS NO. 5

	Area	Per Cent of Total
Muck	55,400	9.5
Bottom Land	7,100	1.2
Farmington (Undifferentiated)	89,600	15.3
Nepean Sand	8,000	1.5
Anstruther Sand	16,600	2.8
Chandos Sand	5,400	0.9
Peat	5,100	0.8
Bridgman	300	0.1
Eastport	1,600	0.3
	189,100	32.4

This group may be classified as submarginal crop land. Because of one or more unfavourable soil or land features, the present economic returns from the production of general farm crops grown on these lands ranges from poor to very poor, and in some cases practically negligible. However, they cannot be considered non-agricultural as selected portions may be used for a specialized type of agriculture which would repay the high operational costs. There are small areas of muck in the Ottawa area which are producing good returns from market gardening. Most of the 55,000 acres are not so favoured either in location or in associated characteristics. Much of the muck of Marlborough is shallow over limestone and subject to drifting once the tree cover is removed.

There are local areas in the Farmington, Nepean, Anstruther and Chandos complexes which would support small patches of garden, etc. In general, however, the best use of this class is either grazing, forestry, wild life preservation or any combination of these. This does not mean that these lands are better suited to these industries than the others, but that they are capable of producing these crops better than they are agricultural ones. Shallowness over bedrock is the limiting factor in the Farmington, Nepean, Anstruther and Chandos complexes. Portions of the Farmington and Nepean are suited to grazing. Only selected clayey portions of the Anstruther or Chandos should be grazed. The shallow, light soils are not capable of supporting a strong enough sod to prevent erosion on the rocky slopes under grazing.

Except where the soil is extremely shallow, trees of merchantable size will grow, and forestry would appear to be the best use over much of the area. Reforestation is most suitable for the drifting sand of the Bridgman and Eastport areas and also on many of the eroded areas along stream courses mapped as Bottom Land. Much of the peat is practically forestless. The extremely wet areas and the extremely rocky areas do produce a certain amount of scrubby vegetation which affords some protection and food for wild life. These areas, together with adjacent forest and broken pasture lands, can be well utilized as recreational lands.

PART V

DISCUSSION OF ANALYTICAL DATA

The results of the chemical analyses of surface soils presented in Table 17 give an indication of the comparative levels of available nutrients in the surface soils of the county. The physical analyses indicate the relative amounts of sand, silt and clay, and in this way serve as a check on the estimates of soil texture in the field.

Sampling

The number of samples taken on each soil type has been governed to a large degree by the extent and importance of that type. The crop history of the fields, from which the samples were taken, in most cases was not obtained. In order to compensate for this, most of the samples were taken from old pastures so that the management factor would be as nearly equal as possible. This has been the regular practice in the Ontario Soil Survey for several years.

Reaction

Most of the soils of the county are near neutral in reaction. There are, however, several soil types which are sufficiently acid that liming should be beneficial for certain crops, particularly the clovers. These types are Rideau

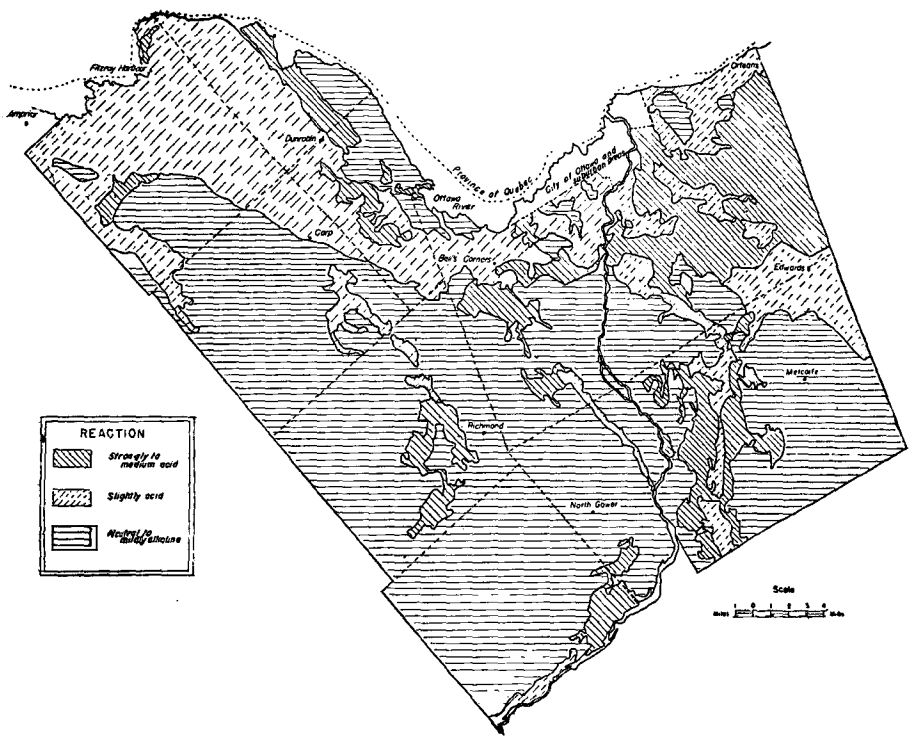


FIG. 15—Map showing areas of approximately similar soil reaction.

clay, Renfrew clay, Elwood clay loam, Castor silt loam, Manotick sandy loam, Rubicon sand, Uplands sand and Nepean sand. It will be noted that the replaceable calcium content of these soils is also low. (See reaction map, Figure 15.)

Phosphorus

The supply of total phosphorus appears to be relatively high in most of the clays of Carleton County compared with many other Ontario soils. The sands on the other hand have a comparatively low supply. This is reflected directly in the supply of readily available phosphorus as the reaction is favourable in most soils, the exception being the more acid sands and the shallow limestone types. The levels of total and readily available phosphorus are given in the following table for the purpose of comparison.

TABLE 16

COMPARATIVE LEVELS OF PHOSPHORUS IN HEAVY SURFACE SOILS IN CARLETON AND PEEL COUNTIES

	Reaction pH	Total Per Cent	Readily Soluble Lbs. P/acre
Carleton County Clays, Averaging 3 Samples*	5.7	0.25	573
Carleton County Clays and Clay Loams, Averaging 34 Samples†	6.7	——	260
Peel County Clays and Clay Loams, Averaging 10 Samples‡	6.8	0.13	——
Peel County Clays and Clay Loams, Averaging 28 Samples**	6.0	——	50

*Samples collected by Field Husbandry Division and analyzed by Chemistry Division, Dominion Department of Agriculture.

†Samples taken during Carleton County Soil Survey. (See Table 17.)

‡Samples taken and analyzed by A. Scott in partial fulfilment of M.S.A. Degree, Ontario Agricultural College.

**Samples taken during Peel County Soil Survey.

From these tables it is evident that the phosphorus in the heavy soils of Carleton County is relatively high. Field observations verify this, only a few crops showing response to the application of phosphate. The very acid clays may, however, be exceptions to this. The sands on the other hand are comparatively low in phosphorus.

In developing the method used in the determination of readily soluble phosphate, the authors, Lohse and Ruhnke, state that soils containing less than 60 pounds of phosphorus per acre appear to indicate very marked phosphate deficiency. No figure has previously been suggested to indicate what might be considered as a sufficient amount for general farm crops. In comparing the results of analysis by this method with those obtained by the Modified Thornton Method* (also commonly used in Ontario), it would seem that 200 pounds per acre might be accepted as a tentative figure for soils which are not too strongly alkaline.

If this figure were accepted it would appear that the following soil types were well supplied with phosphorus—North Gower clay loam and shallow muck phase, Rideau clay, Bearbrook clay and most of the Carp clay loam. Phosphorus appears to be deficient in Nepean sand, Rubicon sand, Uplands sand, Ellwood clay loam and Galesburg sandy loam. Some of these types have not been sufficiently sampled to give more than a general indication.

Potassium

The figures for replaceable potassium give a good index to the amounts of this element which are available to the growing crops. In any given soil they may be varied by good or poor management, but for comparative purposes they may be considered as reasonably constant. Approximately 167 pounds potassium (200 pounds K_2O) per acre plow depth is generally considered necessary for production of general farm crops and somewhat larger amounts for such crops as potatoes and sugar beets.

With this figure in mind it can be readily seen that the clay and clay loam soils are well supplied with potassium but that most of the lighter textured soils are deficient.

Calcium

All these soils contain a plentiful supply of calcium for plant nutrition although some of the more acid soils may require liming to correct the acidity. The largest amounts of calcium are found in the North Gower and Carp series and the smallest in Uplands.

Magnesium

Only the water soluble magnesium has been determined on these soils. Magnesium deficiency may be indicated where there is less than 40 pounds per acre. Nepean sand, Uplands sand, Rubicon sand and Granby sand are the soils which appear to be deficient in magnesium.

Organic Matter

The amounts of organic matter are lowest in the well-drained sands and highest in the poorly drained clays. The Renfrew clay contains somewhat less than the other heavy soils. This constituent varies to a considerable degree with variations in soil management. As these soil samples were taken mostly from old pastures the variable factor of management is reduced to a minimum.

*Ruhnke, Rivaz, and Ewen—A comparative study of rapid chemical tests and Neubauer analyses on some typical Southern Ontario soils. Scientific Agric. 19: 199, 1938.

TABLE 17

CHEMICAL AND PHYSICAL COMPOSITION OF SAMPLES OF SURFACE SOIL FROM CARLETON COUNTY, ONT.[1]

Type	Sample No.	Location			Sand	Silt	Clay	Reaction pH (Glass Electrode)	Phosphorus Readily Soluble[2] lbs. P/acre	Potassium Replaceable[3] lbs. K/acre	Calcium Replaceable[4] lbs. Ca/acre	Magnesium Water Soluble[5] lbs. Mg/acre	Organic Carbon[6] per cent	Organic Matter[7] %C x 1.724
					Bouyoucos Hydrometer									
		Township	Con.	Lot	per cent 1.0—.05mm	per cent .05—.002mm	per cent < .002mm							
Bearbrook Clay	17	Gloucester	3	1	17.6	38.4	44.0	6.70	372	271	10280	56	3.94	6.80
Carp Clay Loam	39	Fitzroy	2	10	29.2	50.6	21.2	7.13	124	206	9440	56	4.69	8.10
	40	Fitzroy	6	4	24.0	45.8	30.2	7.75	380	194	11040	40	2.83	4.88
	41	Fitzroy	8	6	9.6	42.0	48.4	7.59	480	362	13120	56	3.45	5.95
	42	Huntley	5	20	33.4	44.6	22.4	6.92	168	204	11680	40	6.12	10.56
Castor Silt Loam	21	Gloucester	9	11	71.6	21.0	7.4	7.00	146	43	2160	56	1.41	2.34
	22	Osgoode	9	6	36.4	50.8	12.8	6.32	134	28	1920	50	1.64	2.83
	23	Osgoode	10	10	40.0	45.2	14.8	5.90	132	36	1800	50	1.71	2.95
	24	Osgoode	11	17	27.2	54.8	18.0	5.93	120	116	2040	50	2.23	3.84
Ellwood Clay Loam	29	Gloucester	G	21	31.2	35.6	33.2	5.44	36	234	3040	50	2.82	4.87
	31	Gloucester	5	18	29.6	38.8	31.6	5.92	40	314	3920	50	2.50	4.31
Farmington (undifferentiated)	10	Osgoode	9	13	28.2	44.8	27.0	7.59	66	240	8640	56	4.65	8.02
	78	Marlborough	6	26	47.6	41.8	10.6	7.63	48	107	6400	56	3.43	5.92
	79	Goulbourn	9	13	51.4	29.2	19.4	7.78	56	106	5680	56	1.88	3.24
	83	Goulbourn	4	7	50.2	33.4	16.4	8.06	156	67	8640	56	2.60	4.48
	84	Marlborough	10	30	36.8	39.8	23.4	7.84	124	88	4920	56	2.31	3.98
	85	Goulbourn	8	6	56.8	30.2	13.0	7.93	90	149	9200	45	2.90	5.00
	87	Huntley	8	11	51.2	29.4	19.4	6.67	88	163	6240	56	2.76	4.76
Farmington Shingly Loam	80	Goulbourn	7	16	46.8	44.6	8.6	5.63	152	188	3560	35	3.26	5.62
	82	Goulbourn	5	11	28.6	40.8	30.6	7.95	128	446	12520	56	3.93	6.78
Farmington Sandy Loam	86	Huntley	9	4	61.6	26.6	11.8	7.72	94	103	4960	56	1.89	3.26
Galesburg Sandy Loam	76	Fitzroy	11	26	57.4	33.2	9.4	6.43	56	148	3600	35	2.43	4.19
Granby Sandy Loam	59	North Gower	4	40	64.6	26.2	9.2	7.92	192	73	6240	56	1.88	3.24
Granby Sand	88	Huntley	5	16	84.2	11.1	4.7	7.12	66	48	4920	20	2.55	4.40
Grenville Loam	4	Osgoode	8	29	29.8	41.2	29.0	7.47	80	151	6920	56	3.43	5.91
	9	Osgoode	7	24	41.0	40.2	18.8	6.93	70	213	5320	56	3.30	5.69
	14	Osgoode	5	35	33.2	44.2	22.6	6.98	67	158	7000	56	3.93	6.78
	47	Gloucester	B.F.	....	42.8	41.8	15.4	7.39	76	167	6720	56	4.17	7.19
	60	North Gower	3	20	40.8	39.4	19.8	7.72	96	135	5960	56	3.02	5.21
	58	North Gower	2	5	29.6	51.0	19.4	7.69	58	151	10120	56	5.15	8.88
Kars Gravelly Sandy Loam	3	Osgoode	2	30	76.6	14.2	9.2	6.38	46	57	1720	40	1.21	2.08
	30	Gloucester	4	7	75.2	13.8	11.0	5.90	18	108	1080	8	.84	1.45
	32	Gloucester	2	13	61.8	23.6	14.6	6.32	136	107	2880	56	1.70	2.93
	36	Fitzroy	1	21	50.8	40.6	8.6	6.95	52	101	5600	45	2.98	5.14
	74	Fitzroy	6	19	54.6	41.0	4.4	6.84	84	135	3240	56	1.75	3.02

TABLE 17 (*Cont'd*)

CHEMICAL AND PHYSICAL COMPOSITION OF SAMPLES OF SURFACE SOIL FROM CARLETON COUNTY, ONT.[1]

Type	Sample No.	Location			Sand	Silt	Clay	Reaction pH (Glass Electrode)	Phosphorus Readily Soluble[2] lbs. P/acre	Potassium Replaceable[3] lbs. K/acre	Calcium Replaceable[4] lbs. Ca/acre	Magnesium Water Soluble[5] lbs. Mg/acre	Organic Carbon[6] per cent	Organic Matter[7] %C x 1.724
					Bouyoucos Hydrometer									
		Township	Con.	Lot	per cent 1.0—.05mm	per cent .05—.002mm	per cent < .002mm							
Manotick Sandy Loam (complex)	37	Fitzroy	1	16	33.6	45.0	21.4	5.79	62	144	2040	50	2.33	4.02
	44	Nepean	A	....	46.4	30.8	22.8	6.33	138	172	5120	50	2.69	4.64
	48	Gloucester	B.F.	10	33.0	45.2	21.8	6.13	140	132	2880	45	2.25	3.88
	51	Gloucester	B.F.	23	50.8	32.8	16.4	6.10	39	132	2000	10	2.51	4.33
	72	Torbolton	3	14	61.6	28.0	10.4	5.82	24	36	1720	45	2.07	3.57
Nepean Sand	62	Nepean	5	31	70.0	24.8	5.2	5.80	20	71	2400	8	2.61	4.50
North Gower Clay Loam	6	Osgoode	9	24	14.2	57.0	28.8	7.62	284	193	12320	56	5.15	8.88
	7	Osgoode	9	29	10.0	64.8	25.2	6.92	154	243	7280	56	3.69	6.36
	8	Osgoode	10	30	12.2	61.8	26.0	7.62	368	131	8320	56	3.45	5.95
	13	Osgoode	5	41	23.2	48.4	28.4	6.72	340	200	8920	56	3.76	6.48
	33	Gloucester	1	21	17.6	42.0	40.4	6.54	364	256	8880	56	2.57	4.43
	46	Gloucester	2	20	17.8	41.0	41.2	6.82	530	336	9680	56	3.17	5.46
	49	Gloucester	B.F.	27	34.8	29.4	35.8	7.63	288	246	12400	56	3.67	6.33
	53	Nepean	3	25	26.2	43.8	30.0	7.89	450	196	12000	56	2.99	5.16
	54	Nepean	1	19	24.8	41.8	33.4	6.68	450	228	8040	56	2.45	4.23
	56	North Gower	1	7	30.2	40.6	29.2	7.48	336	220	10640	56	4.09	7.06
	63	Nepean	1	20	25.8	47.2	27.0	7.18	350	284	9440	56	3.72	6.42
	64	Nepean	1	20	25.2	52.4	22.4	6.86	250	396	13520	56	8.24	14.20
	65	Goulbourn	5	25	31.0	42.8	26.2	7.36	290	260	10920	56	4.50	7.76
	66	Goulbourn	6	27	26.8	68.0	5.2	7.94	610	184	14800	56	4.38	7.56
	70	Torbolton	3	3	13.4	28.6	58.0	6.92	228	358	9840	56	3.14	5.42
	75	Fitzroy	10	21	16.0	37.6	46.4	6.50	610	508	9440	56	3.13	5.40
North Gower Clay (shallow muck phase)	5	Osgoode	7	36	23.6	44.6	31.8	6.92	320	412	14800	56	8.44	14.54
	25	Osgoode	4	32	36.2	37.0	26.8	7.70	500	188	10520	56	5.26	9.07
Osgoode Loam	1	North Gower	2	34	58.4	29.4	12.2	6.92	172	64	3880	56	2.33	4.02
	26	Osgoode	B.F.	34	31.6	46.0	22.4	6.34	170	153	5800	56	3.50	6.04
	55	North Gower	A	16	42.6	38.6	18.8	6.92	158	119	4400	56	2.22	3.83
	57	North Gower	1	24	30.6	45.8	23.6	6.40	96	176	5800	56	3.73	6.43
	67	Goulbourn	5	24	37.2	47.6	15.2	7.90	340	77	9080	40	2.54	4.38
Rubicon Sand	11	Gloucester	6	20	76.6	15.1	8.3	5.78	32	46	1840	45	2.26	3.90
	20	Gloucester	6E	11	84.7	9.7	5.6	5.95	14	25	1280	8	1.75	3.02
	27	Osgoode	1	27	76.4	14.7	8.9	5.38	30	30	1200	5	2.75	4.74
	81	Goulbourn	10	15	78.4	16.5	5.1	5.83	16	98	2920	30	3.50	6.04
Rideau Clay	15	Gloucester	1	17	16.2	25.0	58.8	5.72	304	452	4000	56	2.79	4.81
	16	Gloucester	1	5	12.6	25.6	61.8	5.73	180	526	7400	56	4.43	7.65

TABLE 17 (*Concl'd*)

CHEMICAL AND PHYSICAL COMPOSITION OF SAMPLES OF SURFACE SOIL FROM CARLETON COUNTY, ONT.[1]

Type	Sample No.	Location			Sand	Silt	Clay	Reaction pH (Glass Electrode)	Phosphorus Readily Soluble[2] lbs. P/acre	Potassium Replaceable[3] lbs. K/acre	Calcium Replaceable[4] lbs. Ca/acre	Magnesium Water Soluble[5] lbs. Mg/acre	Organic Carbon[6] per cent	Organic Matter[7] %C x 1.724
					Bouyoucos Hydrometer									
		Township	Con.	Lot	per cent 1.0—.05mm	per cent .05—.002mm	per cent < .002mm							
Rideau Clay	34	Gloucester	2	20	16.4	41.6	42.0	5.89	196	294	6120	56	2.80	4.83
	45	Nepean	A	45	22.6	36.6	40.8	5.70	116	480	3360	56	2.97	5.12
	61	Nepean	3	16	10.6	35.2	54.2	5.80	360	384	5880	56	3.02	5.21
	69	South March	4	24	26.0	28.0	46.0	6.00	208	416	5680	56	2.83	4.86
	71	Torbolton	4	12	20.8	23.6	55.6	5.69	280	506	7040	56	2.28	3.93
	89	Nepean	B	25	29.4	27.4	43.2	5.95	150	355	5080	56	3.91	6.74
	52	Nepean	H	25	32.0	38.6	29.4	6.40	224	229	4320	56	2.15	3.71
	73	Fitzroy	6	17	12.2	59.2	28.6	6.82	200	168	6000	56	2.81	4.85
	77	Fitzroy	10	12	17.0	43.8	39.2	6.57	320	372	8560	56	3.21	5.54
Renfrew Clay	35	Admaston	5	17	18.0	26.2	55.8	6.02	142	364	3200	56	1.99	3.43
	38	Fitzroy	3	14	17.6	48.0	44.4	5.23	104	204	1600	56	1.88	3.24
Uplands Sand	2	Nepean	4	8	78.9	13.0	8.1	6.02	82	64	1120	10	1.38	2.38
	18	Gloucester	3	5	83.7	11.7	4.6	5.93	39	80	1280	20	2.07	3.57
	19	Gloucester	5E	15	82.1	12.0	5.9	5.72	20	112	960	10	2.63	4.53

[1]Samples were taken during course of the soil survey in 1940. Old pastures representative of the type were selected whenever possible. A few samples from forested areas are exceptions to this. The analyses of mineral constituents were performed by Mr. A. S. Fleming. The mechanical analyses and determinations of organic matter were made by Mr. A. L. Willis.

[2]Lohse and Ruhnke's method of determining readily soluble phosphorus was employed. For discussion of this method see Lohse, H. W., and Ruhnke, G. N., "Studies of Readily Soluble Phosphorus in Soils"—*Soil Science* 35 : 6, 1933.

Lohse and Ruhnke state that it has been the experience of this institution (Ontario Agricultural College) that soil samples containing 30 mgm. or less of P per 1000 gms. of soil (60 lbs. per acre) appear to indicate very marked phosphate deficiency.

[3]Replaceable potassium—Volk and Truog's method of determining replaceable potassium was employed. For discussion of this method see: Volk, N. J., and Truog, E., "A Rapid Method of Determining the Readily Available Potash of Soils"—*Jour. Amer. Soc. of Agron.* 26, 537–46, 1934.

Volk and Truog, in discussing the ammonium acetate method for determining available potash, state that, although approximately 200 lbs. per acre (166 lbs. K) for the plowed layer of loam soils has been set as the minimum amount which probably suffices, a number of factors may alter this amount. Approximately this amount is required in the northern states for the production of maximum yields of corn, small grains and clover. Potatoes, tobacco, sugar beets and other truck crops require more than 200 lbs. per acre for maximum growth.

[4]The replaceable calcium was determined on the same extract that was used in the determination of potassium.

[5]Spurway's method of determining water-soluble magnesium was used. For a discussion of this method and the calibration of the tests, see: Spurway, C. H., "Soil Testing"—*Tech. Bul. No. 132*, Michigan State College.

[6]The organic carbon was determined by the chromic acid method described by Allison, L. E., "Organic Soil Carbon by Reduction of Chromic Acid"—*Soil Science*, Oct. 1935, p. 311.

[7]The organic matter data was obtained by applying the factor 1.724 to the per cent of organic carbon.

APPENDIX

Soil Survey Methods

The purpose of a soil survey is essentially to establish an inventory of the soil resources and to record the information on maps and in a written report. The soils are studied, classified, mapped and described by men who are specially trained in soil science. They are examined in depth as well as on the surface, and such factors as texture, stoniness, structure, colour, organic matter content, etc., are noted. The topography and drainage, native vegetation, crops grown and amount of erosion are also noted and correlated.

Before starting the field work a study is made of any general information available in the literature concerning the formation of soils in the area. This may include reports on the surface geology, physiography, climate, natural vegetation, type of agriculture, etc. When the field work starts, one of the first objectives is to make several cross-section tours to study the general soil profile development and determine the main soil types in the area.

The soil survey conducted in Carleton County may be classed as a detailed-reconnaissance type of survey. Traverses were made along all roads passable by car, and extra traverses were made on foot wherever necessary, in order to obtain the required amount of detail. Wherever available, cross sections along road-cuts were studied, and elsewhere the soil was examined in depth by making a boring with a one-and-a-half-inch auger, or by digging a pit with a spade or shovel.

Notes were taken continually during the survey, and the locations of boundaries between soil types were plotted on base maps with a scale of one inch = one mile, as supplied by the Hydrographic and Map Service, Ottawa.

Several representative samples of the surface soil were taken from each of the more important agricultural types. These samples were taken from fields which had been in sod for at least two or three years and which had not been recently manured or fertilized. The results of the analyses of these samples are reported elsewhere in this report.

GLOSSARY*

Argillaceous materials: Materials having a large percentage of clay (shales, slate, etc.).

Calcareous materials: Materials having a large percentage of lime (limestone, dolomite, etc.).

Catena: A group of soils developed from similar parent material but differing in profile characteristics, owing to differences in relief and drainage.

Colloid: Matter having very small particle size. Clay particles are the common inorganic colloids and humus the common organic colloids in soil.

Complex (soil): An intimate mixture of areas of soil series, types or phases which cannot be indicated separately upon maps of the scale in use.

Deltaic materials: Sandy and silty materials carried by streams into lakes or other large bodies of water where they settle to form a delta.

Drift: Material of any sort deposited in one place after having been moved from another.

Glacial Drift: Refers to all materials deposited by a glacier.

*Partly after Soils and Men, U.S.D.A. Year Book, 1938.

Drumlin: An oval hill of glacial drift normally compact and unstratified.

Erosion: The wearing away of the land surface by running water, wind, ice, etc.

Sheet erosion: Removal of a more or less uniform layer of material from the land surface.

Rill erosion: Formation by water of channels small enough to be obliterated by tillage.

Gully erosion: Formation of channels larger than rills.

Fertility (of soil): The quality that enables a soil to provide the proper compounds, in the proper amounts and in the proper balance for the growth of specified plants, when other factors, such as light, temperature, and the physical condition of the soil, are favourable.

Glei: A soil horizon in which the material has been modified by an alternate oxidation and reduction owing to a fluctuating water table. It is frequently mottled with rusty-brown and often consists of bluish-grey or olive-grey materials more or less sticky, compact and often structureless.

Glacio-fluvial: Materials deposited by glacial streams.

Horizon (soil): See Profile.

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

Impervious materials: Those which resist the passage of drainage water and plant roots.

Intrazonal soil: Any soil with more or less well-developed characteristics that reflects the dominating influence of some local factor of relief, parent material or age over the normal effect of the climate and vegetation.

Lacustrine materials: Materials deposited by lake waters.

Mineral soil: Any soil composed largely of mineral matter as differentiated from mucks and peats which are organic soils.

Morainic materials: See till.

Muck: Fairly well-decomposed, organic soil material, relatively high in mineral content, dark in colour, and accumulated under conditions of imperfect drainage.

Nutrients (plant): The elements taken in by the plant, essential to its growth and used by it in the elaboration of its food and tissue.

Organic soil: Any soil, the solid part of which is predominantly organic matter.

Parent material: The material from which the soil profile develops, or the unweathered or only slightly altered materials beneath the soil mass.

Physiographic: Pertaining to the physical features of the earth's surface, such as its surface, form, drainage, etc.

Peat: Unconsolidated material, consisting largely of undecomposed or slightly decomposed organic matter accumulated under conditions of excessive moisture.

Petrographical: Pertains to the structural, mineralogical and chemical characteristics of rocks.

pH: A notation to designate relatively weak acidity and alkalinity—pH 7.0 indicating precise neutrality, higher values alkalinity and lower values acidity.

Phase: A subdivision of a soil type on the basis of important practical factors, such as relief, stoniness, erosion, etc.

Podsolization: A term referring to the process in which one soil horizon (the A) is depleted of its bases and becomes acid, and another horizon (the B) increases in content of precipitated colloids.

Productivity (of soil): The capability of a soil for producing a specified plant or sequence of plants under a specified system of management.

Profile (soil): A vertical section of the soil through all its horizons and extending into the parent material.

A soil horizon is a "layer" of soil approximately parallel to the land surface, with more or less defined characteristics that have been produced through the operation of soil-building processes. The relative position of the several soil horizons in the soil profile and their definition follows:

A Horizon: The zone of leaching.

A_0 Horizon of partly decomposed, organic debris not mixed with mineral soil.

A_1 Dark-coloured horizon of maximum mixing of organic and mineral soil materials.

A_2 Greyish horizon of maximum leaching.

A_3 Transitional from A to B but more like A than B. Sometimes absent.

B Horizon: Zone of accumulation of precipitated colloids.

B_1 Transitional from A to B but more like the B than A, sometimes absent.

B_2 Deeper-coloured horizon representing the zone of maximum accumulation of precipitated colloids.

B_3 Transitional to C. Frequently leached.

C Horizon: Slightly weathered parent material.

D Horizon: Slightly weathered or unweathered material different from that from which the soil has developed.

G Horizon: This represents the glei layer which occurs only where the water table fluctuates within the soil profile supplementing or replacing the B horizon.

Reaction (soil): The degree of acidity or alkalinity of the soil mass expressed in pH values or in words as follows:

Strongly acid	pH 5.1 to 5.5
Medium acid	pH 5.6 to 6.0
Slightly acid	pH 6.1 to 6.5
Neutral*	pH 6.6 to 7.3
Mildly alkaline	pH 7.4 to 8.0

*NOTE.—Strict neutrality is precisely pH 7.0.

Relief: The elevations or inequalities of a land surface, considered collectively.

Series (soil): A group of soils having profiles differing mainly in minor variations in texture.

Siliceous materials: Materials having a large percentage of silica, such as sandstones, granites, gneisses, etc.

Soil: A natural body on the surface of the earth, composed of organic and mineral materials and constituting the natural medium for the growth of plants. (See soil profile.)

Stratified: Composed of, or arranged in, strata or layers, as applied to geologic materials.

Structure (soil): The aggregates in which the individual soil particles are arranged, e.g., massive structure refers to large uniform masses of cohesive soil.

Structure (geologic): Refers to the type of rocky particles or fragments and their arrangement within the geologic deposit, whether unassorted or sorted and layered. This should not be confused with soil structure which results from soil weathering.

Texture: The relative proportion of the various sized groups of individual soil grains.

Soil separates: The individual size groups of soil particles, such as sand, silt and clay.

Sand	1.00 to 0.05 millimeters in diameter.
Silt	0.05 to 0.002 millimeters in diameter.
Clay	less than 0.002 millimeters in diameter.

Soil Classes:

A. Clay soils, a collective term referring to all soils with more than 20% clay.

Clay loam, 20% to 30% clay and less than 50% silt.
Silty clay loam, 20% to 30% clay and more than 50% silt.
Clay, over 30% clay.
Heavy clay, over 50% clay.

B. Loam—soil with less than 20% clay, less than 50% silt, and less than 50% sand.

C. Sandy loam—soil with less than 20% clay and 50% to 80% sand.

D. Sand—soil with more than 80% sand.

E. Silt loam—soil with more than 50% silt and less than 20% clay.

Till: An unstratified deposit of clay, sand, gravel and boulders transported by glaciers.

Type: A subdivision of a soil series based on differences in texture of the surface soil.

Water table: The upper limit of that part of the soil or underlying material which is wholly saturated by water.

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

Zonal soil: Any one of the great soil groups having well-developed soil characteristics that reflect the influence of climate and living organisms, chiefly vegetation.