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SOIL SURVEY OF GRENVILLE COUNTY

BY
N. R. RICHARDS
EXPERIMENTAL FARMS SERVICE
AND
B. C. MATTHEWS and F. F. MORWICK
ONTARIO AGRICULTURAL COLLEGE

GUELPH, ONTARIO
DECEMBER 1949

REPORT No. 12 OF THE ONTARIO SOIL SURVEY

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

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PREFACE

The soils of Grenville County were surveyed during the summer of 1945.

Other Counties and Districts surveyed and maps published are as follows:

1. *Norfolk*.....*Map only*
2. *Elgin*.....*Map only*
3. *Kent*.....*Map only*
4. *Haldimand*.....*Map only*
5. *Welland*.....*Map only*
6. *Middlesex*.....*Map only*
7. *Carleton*.....*Map and Report*
8. *Parts of Northwestern Ontario*.....*Map and Report*
9. *Durham*.....*Map and Report*
10. *Prince Edward*.....*Map and Report*
11. *Essex*.....*Map and Report*

Soil Erosion and Land Use Survey, Hope Township Project Area.....*Map and Report*

In addition to the above the following Counties have been surveyed:

Oxford	*Peel*
Wentworth	*Dufferin*
Halton	*Northumberland*
York	*Perth*
Peterborough	*Huron*
Brant	*Simcoe*
Waterloo	*Wellington*
Lincoln	*Dundas*
Grey	*Russell*
Bruce	*Stormont*

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ACKNOWLEDGMENTS

The Dominion Department of Mines and Resources, Surveys and Engineering Branch, Hydrographic and Map Service, supplied the base maps. The final copy of the Soil Map for lithographing was prepared by the Cartographic Section of the Division of Field Husbandry, Soils and Agricultural Engineering, Central Experimental Farm, Ottawa.

Helpful suggestions pertaining to classification and correlation, and assistance in critically reviewing the manuscript came from Dr. P. O. Ripley, Dr. A. Leahey, Mr. P. C. Stobbe, Dominion Department of Agriculture and others.

The assistance of Mr. M. C. McPhail and Mr. W. B. George in arranging accommodation for the survey party at the Kemptville Agricultural School is gratefully acknowledged.

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FIG. 1—Outline map of Ontario showing the location of Grenville County and other areas for which soil maps have been published.

Soil Survey of Grenville County, Ontario

by

N. R. RICHARDS, B. C. MATTHEWS and F. F. MORWICK*

SUMMARY

The Soil Survey of Grenville County was conducted during the summer of 1945 as a co-operative project between the Soils Department, Ontario Agricultural College, Guelph and the Division of Field Husbandry, Soils and Agricultural Engineering, Experimental Farms Service, Ottawa. The project consists of two parts, the preparation of the Soil Map and the Soil Survey Report.

The *Soil Map* shows the distribution and area of the different soils found in the County. Through the lot numbers and concession lines the property owner can plot his location on the map. The *Soil Report* contains information as to the formation, character, capabilities and limitations of the soils in the County. The survey was conducted on the scale of one inch to one mile. Consequently the scale of mapping would not permit the delineation of areas of twenty-five acres and less in size.

To establish an inventory of the land resources of an area it is first necessary to have a sound and basic knowledge of the quantity and quality of the soils. The soils of Grenville County have been classified and mapped according to differences in texture, drainage, topography, stoniness, chemical and physical characteristics, etc.

As a result of land clearing and the use of land for agricultural purposes the natural balance between the soils and the original forest cover has been disturbed. The various soils mapped in Grenville County may be associated with different problems of use and management. To assist in the interpretation of the Soil Survey some of those problems or hazards are discussed, and outline maps showing the distribution of drainage classes, stoniness classes and eroded areas are presented.

Drainage

In the production of most cultivated farm crops the natural drainage of the soil is an important factor in determining whether and how successfully a particular crop can be grown. Six drainage classes were recognized in Grenville County.

Good to excessive includes soils that are formed on coarse sandy materials and have little ability to retain moisture. These soils are susceptible to drought and wind erosion.

Good drainage. The soils included in this group possess the most satisfactory moisture relationships for the production of farm crops. Not only do they exhibit the most satisfactory drainage characteristics for crop production, but the favourable moisture relationships are also demonstrated in the well developed colour and textural profiles.

*The analytical work for the report was done by Dr. A. L. Willis, Messrs. H. S. Ive, D. W. Hoffman and A. B. Olding; Miss G. V. Palmer assisted with drawing maps, charts, etc.

Imperfectly drained soils. The capability of imperfectly drained soils to produce crops commonly grown in the area is limited by unsatisfactory moisture relationships. Although little drainage improvement has been practiced on these soils, altered drainage would increase their usefulness.

Poorly drained soils are water saturated for all or part of the season. Often because of unfavourable seasonal conditions it is impossible to plant cereal grains on these soils, with the result that large acreages remain in forage crop land of only mediocre quality. Drainage is desirable and necessary to extend and increase the usefulness of the poorly drained soils.

Very poorly drained soils contain the peat and muck deposits. Often the organic soils are submerged under water for part of the season. Under present conditions these soils are not used for agricultural purposes. They do, however, serve a very useful function as moisture reservoirs, as hunting and trapping areas, and for the forest products obtained from them.

Variable drainage conditions are associated with the shallow soils underlain by limestone bedrock. In the spring of the year they are frequently oversupplied with moisture, but during July and August dry out and become droughty.

TABLE 1

DRAINAGE OF GRENVILLE COUNTY SOILS

Drainage Class	Acreage	Per Cent of Total
Good to Excessive	18,000	6.0
Good	55,000	18.6
Imperfect to Poor	59,000	19.9
Poor	101,000	34.2
Very Poor	16,000	5.4
Variable	47,000	15.9

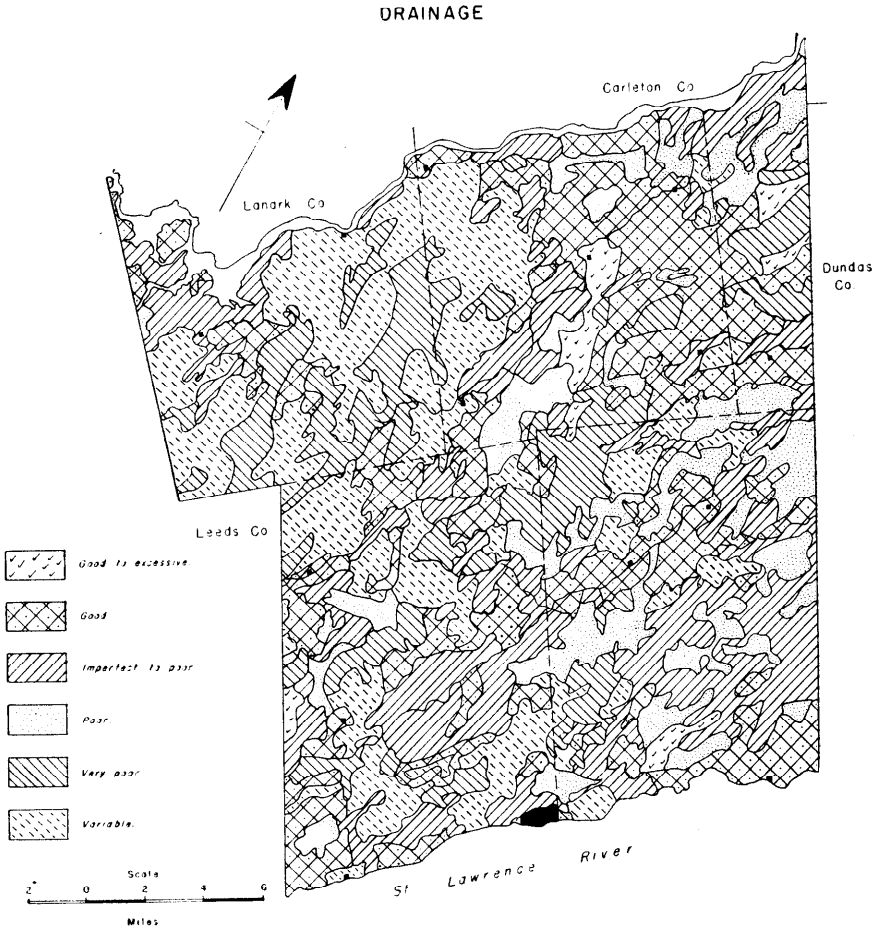


FIG. 2—Outline map showing drainage classes.

Stoniness

For the most part the soils of Grenville County are stonefree. However, there are areas where stones occur in sufficiently large numbers to limit and even prohibit cultivation. The soils of the County have been separated into four groups to express the "stoniness" factor.

Stonefree as the name implies includes soils that are essentially free from stones.

Few stones includes areas where stones are found on the surface and distributed in varying amounts and proportions throughout the soil profile. The stones are well rounded and for the most part range in size from less than an inch to four inches in diameter. Stones are not present in sufficiently large numbers to interfere with cultivation and it is seldom necessary to pick and haul them from the fields.

Numerous stones includes areas where stones occur in sufficiently large numbers to necessitate picking and hauling from the fields. Often they are an obstacle to cultivation and the stoniness hazard is sufficiently great that some areas are better suited for permanent pasture purposes. The stones are usually rough and angular, a large proportion of them being fragments from the underlying bedrock.

Bedrock outcrop and boulders includes areas where the bedrock occurs at very shallow depths as well as the bouldery phase of the till soils. The nearness of bedrock to the surface and the occasional outcrop makes cultivation practically impossible. The distribution of the stoniness classes is shown in Figure 3.

TABLE 2

STONINESS OF GRENVILLE COUNTY SOILS

Stoniness Group	Acreage	Per Cent of Total
Stonefree	173,000	58.5
Few	6,000	2.0
Numerous	67,000	22.6
Outcrop	50,000	16.9

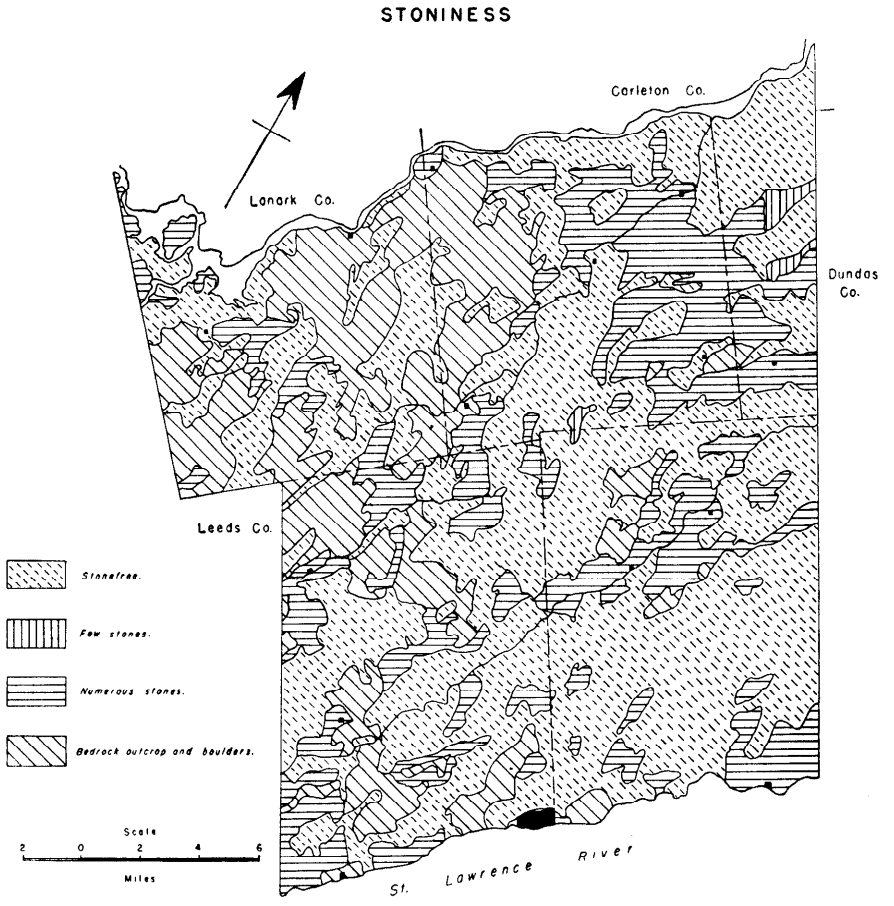


FIG. 3—Outline map showing distribution of stoniness groups.

Erosion

The topography of Grenville County in general ranges from undulating to gently rolling and reaches rugged proportions in a few areas. For the most part the area has suffered only slightly from the ravages of water erosion. A generalized summary of the extent to which erosion has affected the soils is indicated in Figure 4.

Little or no erosion. Most of the soils contained in this class have slopes of 3 per cent and less. Included in this group are the level sandy soils, the level, poorly drained clays, the shallow limestone soils, muck, and peat.

Slight erosion. The soils in this group have been only slightly affected by water erosion. Slopes usually range from 5 to 8 per cent.

Moderate to severe wind erosion. Since the soils contained in this group possess low fertility levels and are excessively drained, they do not provide a vegetative cover sufficiently dense to prevent wind erosion. The percentage of moderately to severely eroded soils is small when compared with the total land area of the County. The slow and relentless operative forces of erosion make it difficult for people living in a community to realize the magnitude of the hazard. However, the denuded shifting sand hills bespeak the need for an action program to overcome this menace.

TABLE 3

EROSION OF GRENVILLE COUNTY SOILS

Erosion Group	Acreage	Per Cent of Total
Little or None	185,000	62.5
Slight	93,000	31.4
Moderate to Severe (Wind Erosion)	18,000	6.1

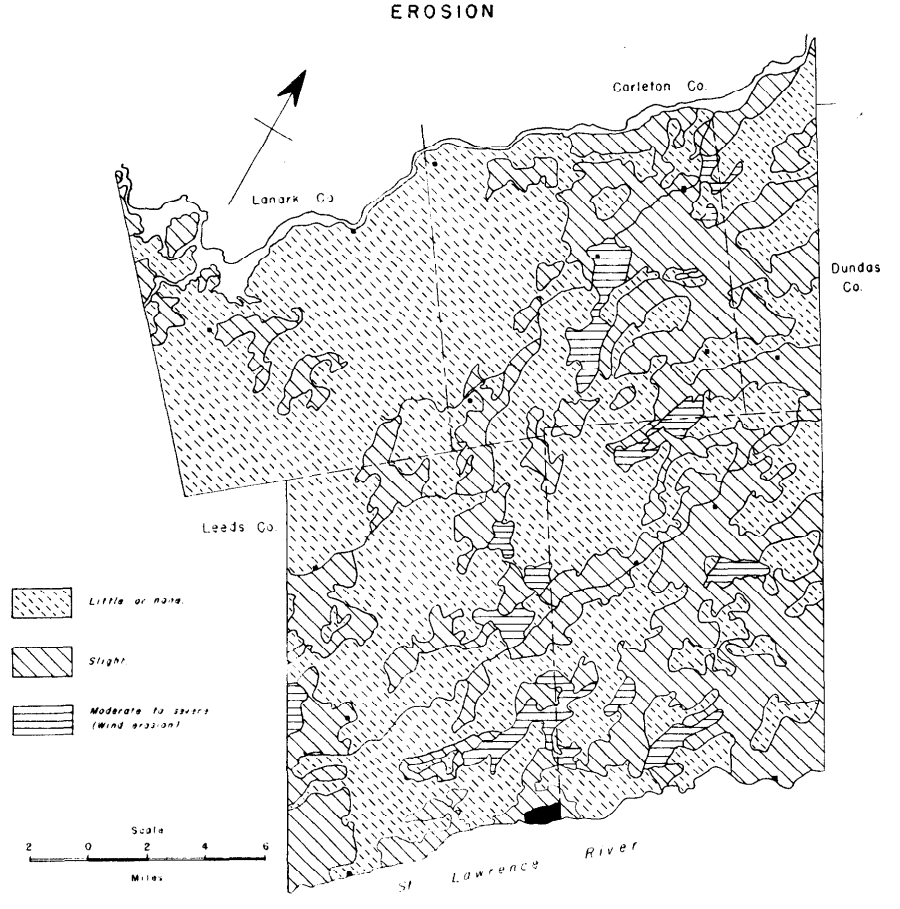


FIG. 4—Outline map showing distribution of erosion classes.

Problem Areas

The Soil Survey of Grenville County revealed that there are definite problems and hazards affecting the use of the soils in this area for agricultural purposes. Accordingly an outline map (Figure 5) has been prepared to indicate the main problem areas in the County. For a more detailed and comprehensive discussion of the problems affecting the utilization of Grenville County soils the reader is referred to Parts III and IV of the Survey Report.

TABLE 4

ACREAGES OF PROBLEM AREAS IN GRENVILLE COUNTY

Area	Problems	Acreage	Per Cent of Total
No. 1	Drainage on imperfectly drained areas. Maintenance of fertility and organic matter levels, and sheet erosion control	64,000	21.7
No. 2	Drainage and fertility maintenance	107,000	36.2
No. 3	Wind erosion and low fertility	22,000	7.4
No. 4	Shallowness over bedrock	62,000	20.9
No. 5	Muck and Peat Bogs	41,000	13.8

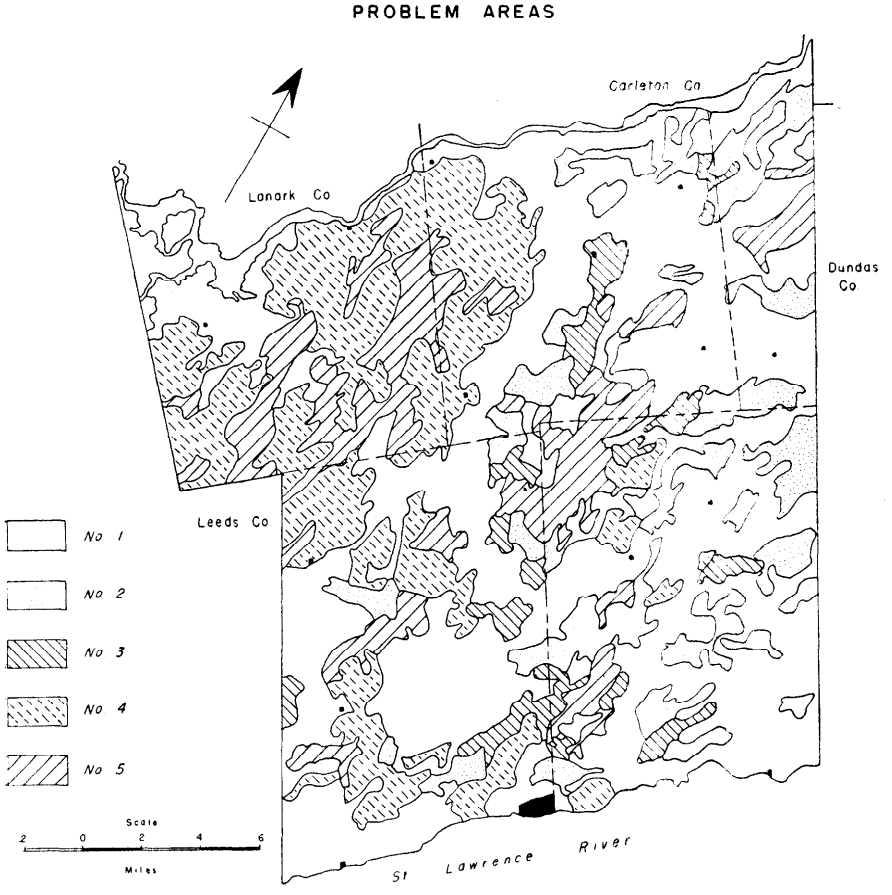


FIG. 5—Outline map showing distribution of problem areas in Grenville County—see Table 4.

PART I

GENERAL DESCRIPTION OF THE AREA

Location and Area

The County of Grenville is located on the northern shore of the St. Lawrence River in Eastern Ontario. It extends north to the Rideau River, where it is bordered by the Counties of Carleton and Lanark. Dundas County adjoins it to the east and Leeds County to the west. Ottawa, the capital city, is situated about thirty miles beyond its northern boundary.

The total land area of the County is approximately 463 square miles (296,000 acres). According to the Eighth Census of Canada, 1941, 257,000 acres or about 87 per cent of the total area is occupied farm land. The remaining 13 per cent is taken up by road allowances, bogs, marshes, etc.

County Seat and Principal Towns

The County town is Prescott situated on the north shore of the St. Lawrence River. Directly across the river, and connected by ferry in summer months, is the City of Ogdensburg, New York, through which a considerable amount of exporting and importing is done. Prescott, with a population of slightly over 3,200, is the largest town in the County.

Kemptville, situated on Provincial Highway No. 16 some 33 miles south of Ottawa, serves an extensive agricultural area. The office of the Representative of the Provincial Department of Agriculture and the Kemptville Agricultural School are located here. This flourishing town of some 1,232 people serves as an agricultural community and educational centre for Grenville County.

Cardinal, located on an artificial "island" in the southeast corner of Edwardsburg Township, has a population of 1,640 citizens. Merrickville on the Rideau River in Wolford Township has about 800 people. In addition to these incorporated urban centres, there are several small villages and community centres such as Maitland, North Augusta and Algonquin in Augusta Township; Spencerville and Ventnor in Edwardsburg Township; Oxford Mills, Burritt's Rapids and Bishop's Mills in Oxford Township; and Easton Corners in Wolford Township.

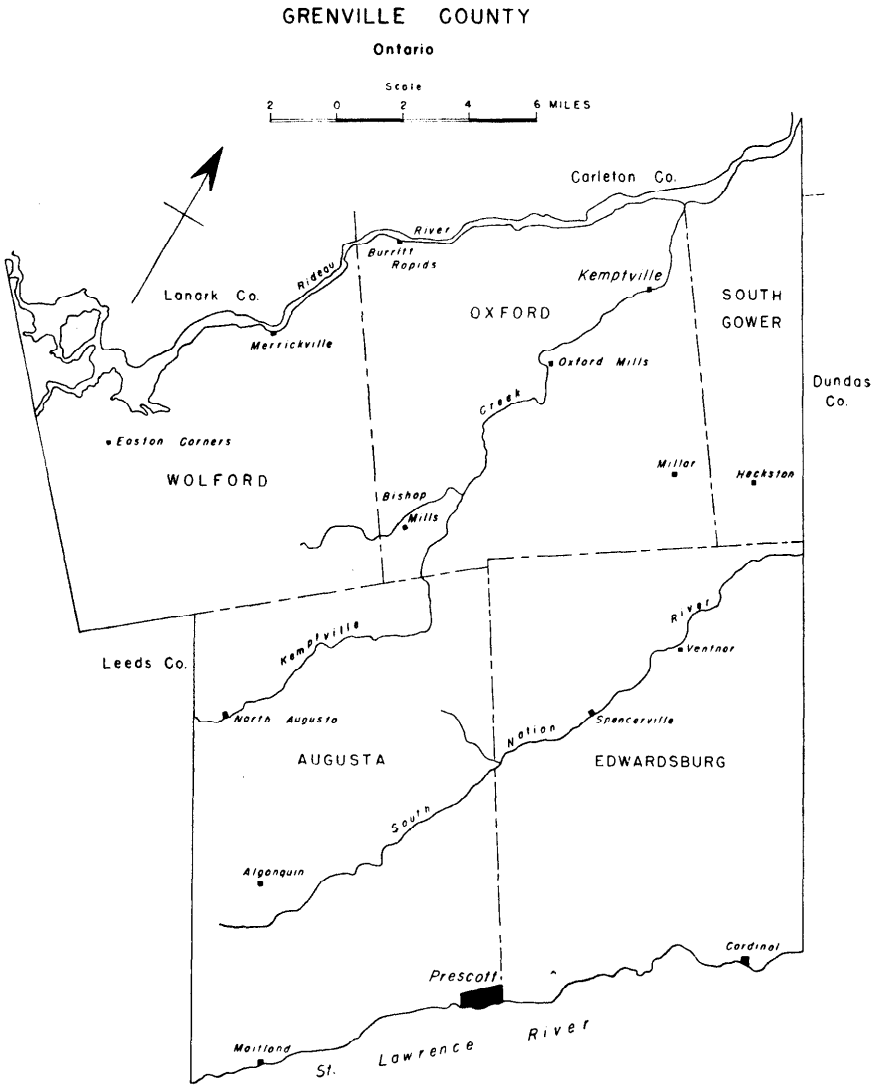


FIG. 6—Map of Grenville County showing townships and principal centres.

Population and Racial Origin

The total population of the County according to the 1941 Census is 15,989. Approximately 56 per cent (9,095) of the people were rural dwellers in 1941, while 44 per cent (6,894) were classified as urban population.

Since 1921 the population of Grenville has remained fairly constant. As the following figures indicate the population decreased rather noticeably between 1871 and 1921.

Trend of Population (Total)

Year	Population	Year	Population
1871	22,616	1911	17,545
1881	22,741	1921	16,644
1891	21,609	1931	16,327
1901	21,021	1941	15,989

A large proportion of the population of Grenville County is of British origin. The following is a table showing the racial class proportion:

Population, 1941 Census

Total population		15,989	100%
Canadians of British origin —	Irish	6,811	44.1%
	English	4,542	28.2%
	Scottish	2,484	15.1%
Canadians of French origin		1,081	6.4%
Canadians of other origin		1,071	6.2%

Transportation and Markets

Grenville County is served by a good network of roads and railways. Highway No. 2 parallels the St. Lawrence River in the southern section of the County. At Johnstown, just east of Prescott, Highway No. 16 swings northward and extends throughout the length of the County and onward to Ottawa, where there is a good market for dairy products and truck crops. The County roads are exceptionally good, several of them being asphalt surfaced. The Township roads are often very winding because of the large areas of muck and peat bogs.

The main line of the Canadian National Railway traverses the southern part of the County, linking it with the port of Brockville on the west and Montreal on the east. In the north the Canadian Pacific Railway line from Montreal to Toronto crosses the area in an east and west direction through South Gower, Oxford and Wolford Townships. A branch line of the C.P.R. from Ottawa extends southward to Kemptville and on through the farming regions of Oxford and Edwardsburg Townships to the port of Prescott. Freighters of the Canadian Steamship Lines provide transportation on the St. Lawrence River. The adequate road and railway facilities serve all parts of the County and provide good communication with eastern and western marketing centres.

PART II

FACTORS AFFECTING THE FORMATION OF GRENVILLE COUNTY SOILS

The transformation of parent material into soil is designated as soil development. Such a transformation is influenced by various factors which include composition of parent material, climate, topography, organisms, and time. Hence, soils being the products of environmental conditions vary where these conditions differ. The action of these factors results in a soil which exhibits a definite construction or build consisting of a number of genetically related horizons that may be described by words and drawings. It is difficult, if not impossible, to measure the effect of any single factor on the formation and development of a soil. However, the cumulative effect of all environmental factors is reflected in the *soil profile*.

Soil Parent Materials

Except for a small Precambrian outcrop in the Oxford Station area, Grenville County is underlain by Beekmantown limestone. For the most part the Beekmantown consists of impure dolomite and magnesian limestones. The following analysis is from a sample procured from a rock cut on the Canadian Pacific Railway line, Lot 2, Con. I, Wolford Township.

ANALYSIS OF BEEKMANTOWN LIMESTONE*

Insoluble Mineral Matter	9.00%
Ferric Oxide	0.43%
Alumina	1.17%
Calcium Carbonate	49.96%
Magnesium Carbonate	39.30%
TOTAL	98.86%

Drift deposited by the melting ice during the Wisconsin Glaciation covers a large part of the County. The deposit of drift over the underlying bedrock is thin, particularly in the central west and northwest half of the area. Some shallow deposits occasionally occur in the eastern half. The drift deposits appear to contain a fairly large proportion of Beekmantown limestone fragments which would indicate they have been strongly influenced by the underlying bedrock.

In the northwest corner of Oxford Township, a large part of Wolford Township, and the central section of Augusta Township, level limestone bedrock plains exist. The veneer of soil materials over the bedrock is usually less than a foot in depth and outcrops are common. The level bedrock plains are occasionally broken by limestone ridges but the topography is predominantly level.

Stony, rolling, limestone till materials are fairly prevalent in Oxford and South Gower Townships, particularly in the Kemptville district and in lesser amounts in the remaining townships of the County. These deposits are characterized by lack of sorting, and contain stones of varying proportions scattered through the matrix of sand, silt and clay.

*Goudge, M. F. Preliminary Report on the Limestones of Quebec and Ontario; Canada, Dept. of Mines, No. 682, 1927.

The till is predominantly of Beekmantown limestone origin. It effervesces with dilute hydrochloric acid but much less freely than till derived from Trenton limestone. Occasional igneous rocks are found but they are very much in the minority. The till materials occur in strongly undulating to rolling plains and lack the characteristic drumlinoid features of similar materials in the North Gower area of Carleton County.

Deposits of heavy clay are frequently found in close proximity to the rivers and streams. The areas are not extensive and it is difficult to trace their origin. It is possible that they might have been deposited at the time of the Champlain Sea invasion. The clays of Grenville County are similar to the limy grey-brown clays of Carleton County. Their topography ranges from level to gently undulating. Occasionally they contain a small amount of grit, but for the most part they are stonefree. The unweathered materials effervesce freely with dilute acid.

The stonefree outwash sands are by far the most extensive group of soil materials found in Grenville County. Large areas of sandy materials are found in South Gower, Oxford, Edwardsburg and Augusta Townships. Ranging in topography from strongly rolling to undulating, they are usually coarse textured and stonefree. The lime content is lower than in the sandy materials of south central Ontario but similar to that of the coarse textured sands of Carleton County. The lower lime content of these materials is possibly explained by their origin in the Precambrian areas to the north. They occur as fairly extensive outwash plains along the Rideau, South Nation and Kemptville Rivers. There is however, a small area in the central section of Edwardsburg Township where the materials effervesce freely with acid and contain considerably more calcium carbonate than in the remainder of the area.

Frequently, deposits of sand of three feet and less are underlain by clay which exhibits characteristics similar to the heavy materials discussed previously. The presence of the heavy textured layer has influenced both soil development and land use.

Organic materials occur in fairly large areas, particularly in the western half of Grenville County. They are largely the remains of decayed trees, plants and mosses. The chemical composition of the organic materials varies, depending on the state of decomposition and the origin of the materials. They may be divided into two classes, peat and muck. The muck occurs in areas where decomposition has been more rapid and in areas that permit satisfactory tree growth. The shallow organic deposits are usually muck. The peat occurs in areas where there has been only scanty tree growth. Here the vegetation consists largely of mosses. Decomposition has been slow and the deposits contain a large proportion of partially decomposed materials.

The distribution of the soil parent materials of Grenville County is indicated in Figure 7.

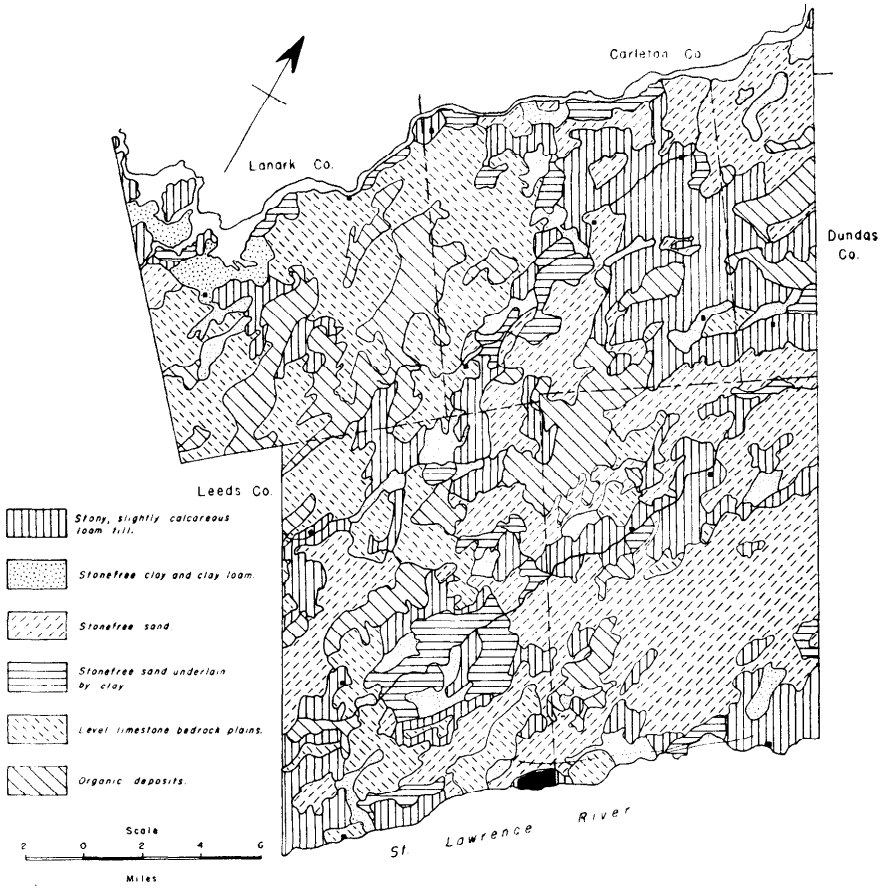


FIG. 7—Outline map showing the distribution of soil parent materials.

Natural Forest Vegetation

The type of natural vegetation found in an area is largely dependent on climatic and soil factors producing suitable environmental conditions in which plants can grow. Once established, vegetation exerts considerable influence on soil development and merits attention as one of the soil forming factors. The extent to which vegetation influences soil development varies with the type of vegetation. Comparing forests which are largely deciduous with those which are coniferous, there is a wide variation in the character of the forest litter, particularly the relative toughness, consistency and chemical content of the leaves.

In classifying and mapping soils, those features of the profile which can be observed and described are used as the criteria for making soil type separations. To develop a system capable of estimating the effect of vegetation on these features would be virtually impossible since vegetation is only one of several inter-related soil forming factors. It is neither the purpose of the soil survey to conduct a vegetation survey, nor prepare a plant ecology report.

Since a large part of Grenville County has been cleared, it is difficult to reconstruct a picture of the natural forest vegetation. This is particularly true of the better agricultural areas where most of the trees have been removed and the land is now under cultivation.

According to Halliday*, Grenville County is situated within the upper St. Lawrence Section of the Great Lakes–St. Lawrence Region. The general character of the tree cover is broad-leaved and there is a fair representation of coniferous growth. No attempt is made in this soil survey report to list the different species of trees found in the area. There are, however, certain combinations or associations of trees that occur more frequently on some soils than others. The associations that are found most frequently are:

White Cedar, Red Cedar, Sugar Maple Association

This association occurs on the shallow soils overlying the limestone bedrock. On the very shallow soils the vegetation appears to be largely white and red cedar with a fair proportion of sugar maple appearing when the soil mantle increases in depth. A fair proportion of the original vegetation remains on the shallow soils, which are not well suited to the growing of cultivated crops.

Sugar Maple, Beech, White Cedar Association

This association is commonly found on the soils that have been formed from the loamy limestone tills. Sugar maple and beech are predominant on the better drained portions with white cedar occurring on the less well drained areas. The white cedar occurs in denser stands on the imperfectly drained areas than on the shallow soils. Locally, within the County, the incidence of hollow cedar trees is considered to be highest on the shallow soils over bedrock.

Pine, Soft Maple, Birch Association

The pine, soft maple, birch combination appears most frequently on the well drained sands. There is only a small portion of this association found in the County at the present time. In the areas that remain, pine would appear to dominate with soft maple and birch being found in lesser amounts.

Elm, Ash, Soft Maple Association

This association occurs on the imperfectly and poorly drained areas. The elm is found in larger numbers on the heavy textured soils, particularly along stream courses.

Tamarack, Black Spruce, Alder Association

Found for the most part on the very poorly drained organic deposits of the County, the tree growth in this association is usually scanty. Frequently, the tree growth has given over to a vegetation cover in which moss predominates.

*Halliday, W. E. D. A Forest Classification for Canada; Canada Dept. of Mines and Resources, Forest Service, Bulletin No. 89, 1937.

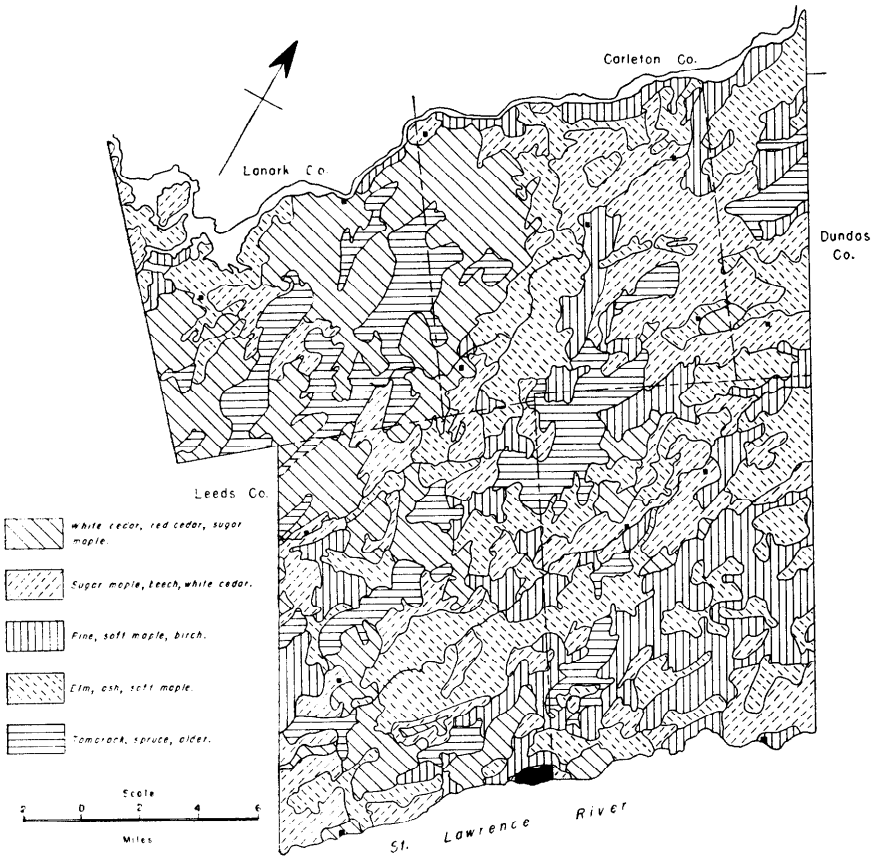


FIG. 8—Outline map showing the main forest associations.

Climate

The influence of climate is important in that it affects fundamental physical, chemical and biological relationships in the soil. Temperature influences the speed of chemical reactions and even after soil development has advanced to a considerable degree there continues to be weathering of mineral particles. The amount of water that actually percolates through the soil material is influenced by rainfall, relative humidity and frost-free period and is an important factor in soil weathering and soil development. The characteristic features manifested in a soil profile are a reflection in part of climatic influences.

However, once an agricultural economy has been established in an area the effect exerted by climate on land use is an important consideration. The suitability of soils for growing different crops and the effect of temperature-precipitation relationships on crop production are in part dependent on climatic factors. Slightly over 15 per cent of the soils of Grenville County have one foot and less of soil mantle over the underlying bedrock. Such areas

respond readily to light rainfall and since they are used extensively as permanent pasture areas the amount and frequency of summer rains greatly influences their usefulness.

Grenville County is located, for the most part, in the Eastern Ontario region as designated by Putnam and Chapman*. The above authors describe the climate for the region as cold and humid. Grenville County, itself, is subjected to greater extremes in climate than the lowland regions of the Great Lakes. The extreme low temperature is −48 and the extreme high temperature is 104.

There is only one meteorological station in the County, and it is located at the Kemptville Agricultural School, where climatic data has been gathered for short and broken periods of time. In order to check the climate in the southern part of the County, it is necessary to use the records from the stations at Morrisburg to the east of the County border and at Ogdensburg immediately across the St. Lawrence River in New York State.

Records from Guelph are included to permit comparison of crop yields at the Ontario Agricultural College with yields obtained in the surveyed area. The data from Simcoe represent the southern hardwood zone, while the Huntsville area is in the transitional zone between the hardwoods and conifers.

TABLE 5

WEATHER RECORDS AT KEMPTVILLE
(Period 1930–37, inclusive, 1940–41–42–44)

	TEMPERATURE			PRECIPITATION			
	Max.	Min.	Mean	Total	Inches Snow-fall	Heaviest Fall (Rain-fall)	Days With .01" or More
January	44.3	−16.3	14.8	2.09	10.6	1.16	7.6
February	42.8	−18.1	14.3	1.41	7.8	0.56	5.0
March	50.2	− 3.0	25.4	2.05	10.7	1.20	8.0
April	75.7	19.9	42.2	2.31	3.4	1.90	7.3
May	85.1	29.1	56.6	2.31	.....	1.65	8.4
June	90.3	38.8	65.2	2.90	.....	1.25	8.8
July	93.4	45.6	69.7	2.57	.....	1.90	9.4
August	91.7	40.9	67.1	2.13	.....	1.46	8.0
September	85.5	31.7	59.8	3.08	.....	2.15	8.0
October	74.4	21.1	46.1	2.24	.....	1.96	9.1
November	63.9	6.4	33.3	2.58	4.0	1.12	7.1
December	44.5	−18.4	17.5	2.50	9.2	0.80	6.6
				28.17			

*Putnam, D. F., and Chapman, L. J. The Climate of Southern Ontario; Sci. Agr. 18 : 8, Apr. 1938.

TABLE 6

MEAN MONTHLY TEMPERATURE FOR KEMPTVILLE AND OTHER SELECTED POINTS

(Temperature in Degrees Fahrenheit)

	Period of Record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Kemptville	†	14.8	14.3	25.4	42.2	56.6	65.2	69.7	67.1	59.8	46.1	33.3	17.5	42.6
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	42.0
Ogdensburg, N.Y.*	....	16.5	16.8	28.7	43.7	56.0	64.8	69.8	67.8	61.2	50.1	35.7	22.0	44.4
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
Guelph	55	20	19	28	42	53	63	68	66	59	47	36	24	44
Simcoe	‡	23.0	23.5	31.2	43.2	54.6	64.6	69.3	67.3	61.6	49.8	38.4	27.5	46.2
Huntsville	30	13	12	22	38	52	61	65	63	56	44	31	18	40

*Soil Survey of St. Lawrence County, N.Y.
†1930–37, inclusive, and 1940, 41, 42, 44.
‡1882–1886 — 1920–1937.

TABLE 7

MEAN MONTHLY PRECIPITATION FOR KEMPTVILLE AND OTHER SELECTED POINTS

(Inches of Precipitation)

	Period of Record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Kemptville	†	2.09	1.41	2.05	2.31	2.31	2.90	2.57	2.13	3.08	2.24	2.58	2.50	28.17
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
Ogdensburg*	....	2.22	2.21	2.40	2.13	2.90	3.29	3.07	2.95	2.91	2.75	2.48	2.39	31.70
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
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
Simcoe	‡	3.51	2.64	2.93	3.20	2.51	2.81	2.92	2.59	3.00	2.68	3.31	2.05	25.15
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

*Soil Survey of St. Lawrence County, N.Y.
†1930–37, inclusive, and 1940, 41, 42, 44.
‡1882–1886 — 1920–1937.

The mean annual temperature for Kemptville is 42.6 deg., while Guelph has a mean annual temperature of 44 deg. and a still higher mean of 46 deg. is recorded at Simcoe. The lowest monthly mean of 14.3 deg. recorded at Kemptville is much below the lowest monthly mean of 23 deg. at Simcoe.

The maximum temperature at Kemptville (69.7 deg.) is much higher than at Simcoe (65 deg.). The mean winter temperature of 14 plus deg. is considerably lower than that of southwestern Ontario. The mean summer temperature of 66 plus deg. is somewhat similar to the more southerly districts.

In general, the temperature of the County, while somewhat lower than in the southwestern Ontario region, is sufficiently high to distinguish it from the Huntsville area. The spring temperatures in particular are more favourable than in the latter area. The fact that there is a climatic and soil difference from the southwestern counties probably explains the increasing numbers of coniferous trees throughout the County.

The moderating effects of the St. Lawrence River on the temperature and on the increase in precipitation are quite evident from Tables 6 and 7 of Kemptville, Morrisburg and Ogdensburg.

This is an important factor favouring the fruit growing endeavours in this southern section of the County.

The low winter temperatures in the County generally forbid widespread fruit and vegetable production as well as hinder the growing of tender cereal grains* and other farm crops. Only the hardy varieties of apples survive more than eight miles distant from the St. Lawrence River.

The average annual precipitation at Kemptville is 28.17 inches which approximates that of Guelph. However, Morrisburg and Ogdensburg at the south of the County record 38.6 and 31.7 inches, respectively. This brings the general average up to about 33 inches, considerably higher than Guelph, Simcoe and other areas in southwestern Ontario.

The amount of rainfall is generally higher in the summer months during periods of higher temperature and increased evaporation. The months of highest rainfall are June and September (see Table 7).

Briefly, the climate of Grenville County is characterized by cold winters with moderate snowfall and warm summers with plenty of rainfall to prevent drought. The cold winters hinder the growth of fall wheat, tender fruits and vegetables, except in the immediate vicinity of the St. Lawrence River. The southern region of the County generally receives more rainfall.

Relief

The relief of Grenville County can be described as level to undulating with frequent outcrops of bedrock. With the exception of the rolling plains which occur in South Gower and Oxford Townships and to a lesser extent in Augusta and Edwardsburg Townships, the relief of the area is rather uninteresting. The level limestone bedrock plains occur in the western half of the County. These are broken by the occasional ridge and bog. Undulating to

*Putnam, D. F., and Chapman, L. J. The Climate of Southern Ontario; Sci. Agr. 18 : 8, Apr. 1938.

slightly rolling sand plains predominate in the southern half of the area. In Wolford, Edwardsburg and the southern section of Oxford Township extensive depressional bogs are found. Level clay plains occur in the northwestern corner of Wolford Township.

The altitude of the County ranges from about 400 feet in the western section to about 250 feet in the south along the St. Lawrence River. There is a gradual drop in altitude from west to east.

Drainage

The northern section of the County is drained by the Rideau River and Kemptville Creek which empties into the Rideau, a few miles north of Kemptville. Kemptville Creek is a slow sluggish stream which traverses the central and northeastern section of the County. It overflows its banks at many points along its course and, in time of high water, floods considerable areas. The central-southern section of the County is drained by the South Nation River. Large areas in close proximity to both these rivers are in need of improved drainage. However, because of the sluggishness of the streams and the difficulty in procuring adequate fall, drainage improvement might present problems. The southern section of Grenville County is drained by small streams emptying into the St. Lawrence River.

Drainage on the shallow soils over bedrock is variable. Occasionally, saucer-shaped areas in the underlying bedrock result in imperfectly and poorly drained conditions. For the most part, however, the shallow soils are well drained. In spite of the fact that Canada's largest river, the St. Lawrence, and three other rivers serve the County, it can be conservatively estimated that over half of the area would respond to drainage improvement. The large expanses of organic soils that occur in the area are an indication of the lack of effective natural drainage.

Age

Grenville County lies within the area that was covered by ice during the glacial period. The soil materials were deposited by the ice itself or by lakes and streams which existed at the time of and during the retreat of the continental glacier. Most of the glacial drift in the surveyed area has been derived from the underlying Paleozoic formations. According to Fairchild*, the region was submerged in the marine waters of Gilbert Gulf, an arm of the Champlain Sea. Antevs† estimates that the Champlain Sea receded about 13,000 years ago. The materials of this area have been exposed to the forces of weathering for a much shorter period of time than those of western Ontario.

Erosion

Grenville County has not suffered extensively from erosion. This is due in no small part to the topographic conditions that prevail in the area. The rolling limestone till plains are most susceptible to water erosion. However, the slopes are short and only moderately steep which lessens the hazard con-

*Fairchild, N. C. Gilbert Gulf, Marine Waters in Ontario Basin; Geol. Soc. Am. Bull., Vol. 17, 1905.

†Antevs, E. Late Quaternary Upwarpings of Northeastern North America; Jour. of Geol., Vol. 47, 1939.

siderably. Large level to undulating areas that are not affected by sheet erosion exist within the County. Wind erosion occurs on the coarse textured sandy materials. Such areas are found in Oxford, Edwardsburg and Augusta Townships. Once the tree cover was removed, the loose coarse textured, unproductive soils did not produce a vegetative cover sufficiently dense to arrest wind erosion. This condition has been aggravated by man's failure to recognize and attempt to remedy the problem.

PART III

THE CLASSIFICATION AND DESCRIPTION OF GRENVILLE COUNTY SOILS

The soils of Grenville County vary from coarse sands to clay, from stone-free to bouldery, and from excessively drained sandy knolls to very poorly drained bogs. Light textured soils (sands and sandy loams) occur in over 50 per cent of the area, while loams and silt loams occupy another 15 per cent. About 20 per cent of the County has a soil mantle of less than one foot over bedrock. Organic soils (muck and peat) occur in the remainder of the area.

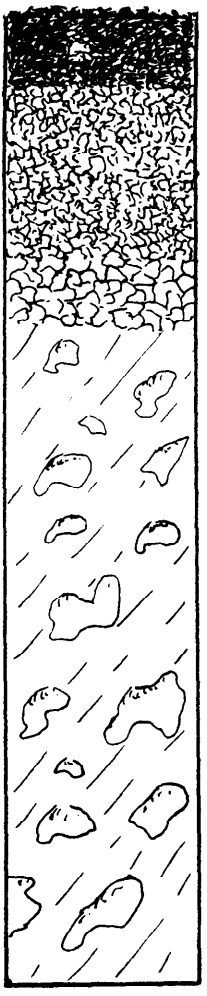
Soils are the products of the environmental conditions under which they have developed or are developing. These conditions in turn are governed by geologic, topographic, climatic and biologic factors. The final result of the interaction of these factors depends on the length of time they have been effective and is revealed in the soil profile.

Soils, for the most part, are classified on the type of formation which is found on the well drained sites within an area, because it is there the effects of regional climate and vegetation are most completely reflected. Mature soils developed under such conditions, even on varying parent materials, acquire similar characteristics and are referred to as "zonal" soils. Within the broad area occupied by zonal soils, local environmental conditions such as poor or excessive drainage, or extreme differences in parent material may so alter the effect of the soil forming processes as to produce a soil markedly different in characteristics from the zonal soil. Such soils are referred to as "intrazonal soils". Those soils which show no characteristic development are referred to as "azonal" soils.

The soils of the Grenville County region have developed under a warm humid climate and a hardwood vegetation with a fair sprinkling of conifers, especially on the lighter textured areas. They do not, however, exhibit the maturity and well developed profile characteristics of the Grey-Brown Podzolic soils found in southwestern Ontario. Neither the colour nor the textural horizons are as well defined which probably reflects the shorter length of time the materials have been exposed to the influence of soil forming processes.

The profiles of the well drained intermediate textured soils exhibit characteristics associated with both the Brown Forest and Grey-Brown Podzolic soils. This lack of profile definition indicates the transitory condition commonly found in the area. Realizing that the soils do possess weakly developed Grey-Brown Podzolic characteristics it is felt that they more closely resemble the Brown Forest soils and for purposes of discussion they are included with that group. Fairly well defined Grey-Brown Podzolics are found on the outwash gravelly soils (Kars), while well developed podzols occur on the well drained outwash sands.

The following description of a Grenville loam profile, developed on limestone till and located in Oxford Township, indicates the type of profile developed in the well drained medium textured soils in the County. This soil has developed under a hardwood tree cover consisting dominantly of maple and beech.



A_0 — Thin mat of partially decomposed leaves, twigs, etc.

A_1 — 3½ inches dark grey-brown (10YR3/2)* loam; fine granular structure; friable consistency; pH — 6.3.

B_1 — 8 inches light yellowish brown (10YR6/4) loam; very fine platy structure; friable consistency; stony; pH — 6.1.

B_2 — 3½ inches brown (10YR5/3) loam; medium nuciform structure; friable consistency; stony; pH — 6.8.

C — Grey (10YR5/1) limestone loam till; frequent stones and limestone fragments; pH — 7.8.

The colour and textural differences between the B_1 and B_2 horizons are only slight. The profile exhibits a yellowish brown cast. Although there may be a very weakly developed A_2 horizon, the profile characteristics appear to be more closely related to the Brown Forest soils than the Grey-Brown Podzolics of Southwestern Ontario.

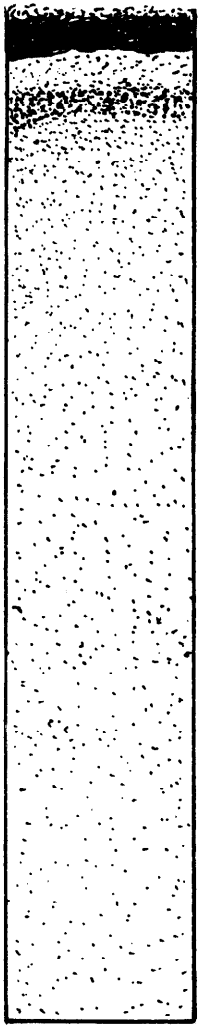
*Colour code number as taken from "Munsell Color Chart."

The Grenville loam is developed on loamy calcareous till. A weakly developed A_2 horizon is present in this profile

The well-drained medium textured soils developed under a vegetative cover consisting of hardwoods such as maple and beech.

On well drained sites of the lighter textured low lime sands well developed podzols occur. These soils have developed under a vegetative cover containing a large proportion of conifers.

The following description of an Uplands sand profile is representative of a podzol found on the coarse textured excessively drained sands.



A_0 — Very thin mat of partially decomposed leaf litter.

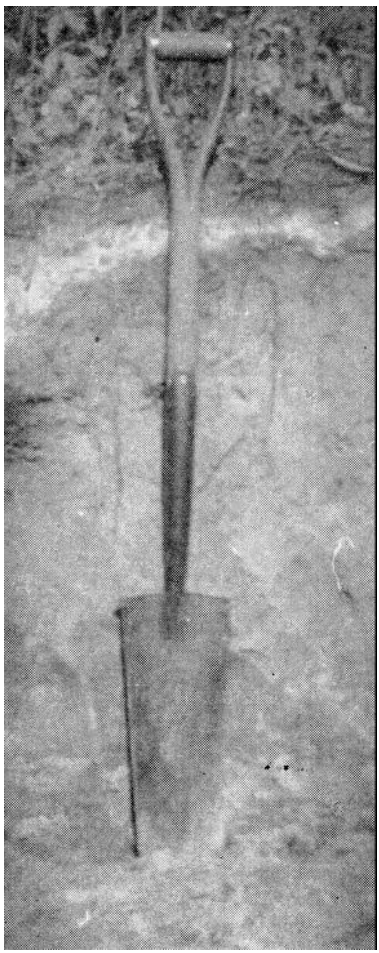
A_1 — 2 inches very dark grey (10YR3/1) sandy loam; single grain to weak crumb structure; extremely friable consistency; pH — 5.8.

A_2 — 1½ inches grey (10YR7/2) sand; single grain structure; pH — 5.2.

B_2 — 2 inches dark brown (10YR4/4) sandy loam; single grain structure; weakly cemented; friable consistency; pH — 6.2.

B_3 — 36 inches yellowish brown (10YR6/6) sandy loam; single grain structure; friable consistency; pH — 6.2.

C — Grey (10YR7/1) sand; frequently well sorted; pH — 7.0.



This picture shows the thin A_1 horizon and the thin highly leached A_2 horizon of a podzol profile. Twenty-two hundred acres of Uplands sandy loam were mapped in Grenville County.

Over 50 per cent of the soils of Grenville County are contained in the "Intrazonal" group, all of which have developed under imperfectly to poorly drained conditions. Local environmental conditions under which these soils have developed differ greatly from those of the zonal soils resulting in marked differences in profile characteristics. Because of high moisture content, lack of air and lower temperature the Intrazonal soils usually contain more organic matter in the surface horizon than the zonal soils and have highly mottled or drab grey subsoils due to lack of aeration.

The Intrazonal soils of Grenville County occur in one of the following groups :

Ground-Water Podzols are imperfectly to poorly drained soils. The Ground-water Podzol differs from the Podzol in that the leached layer (A_2 horizon) is thicker, the B_2 is indurated and the B_3 is highly mottled. For a more complete description of the Ground-water Podzol, the reader is referred to the description of the Rubicon Series (page 55).

A fairly large proportion of the medium and heavy textured soils of Grenville County have developed under excessive moisture relationships. This condition, along with the relatively short time soil forming processes have been operating, has resulted in the development of a featureless profile. This group exhibits characteristics intermediate between the Grey-Brown Podzolics and the shallow organic soils. These soils have a dark grey mineralized A_1 horizon which rests on a mottled grey or greyish brown subsoil. Immediately below the A_1 horizon a shallow layer with smaller structural aggregates than the succeeding G horizon often occurs. Tentatively the name "Dark Grey Gleisolic" has been proposed for this group of soils. The series description of the Lyons (page 46) or the North Gower (page 62) indicate the common characteristics of this proposed group.

Elm predominates in the natural vegetative cover of the Dark Grey Cleisolic soils.

A small percentage of the soils in Grenville County are azonal. The Bottom Land which occurs adjacent to stream courses has not well developed profile characteristics because of periodic flooding and is an Alluvial soil.

Organic Soils: This group contains the Muck and Peat deposits. These soils have developed under very poor drainage conditions and a vegetative cover of elm, tamarack, reeds, cattails, moss, etc. The Peat and Muck usually exceed three feet in depth. Where the organic layer is less than twelve inches the soils are considered as "shallow organic." The subsoil is usually a drab grey or highly mottled mineral soil.

Again it is well to reflect that, some of the groups are not well defined but exhibit some characteristics common to one or more groups. According to their characteristics certain soils may be transitional, but they have been included with the Great Soil Group they most closely resemble.

System of Classification

On the basis of their differentiating characteristics, soils are grouped into categories which can be described and readily recognized. Those categories commonly used in mapping soils are the series, type, and phase.

The soil series is a group of soils having genetic horizons similar as to differentiating characteristics and arrangement in the soil profile and developed from a particular type of parent material. With the exception of texture, particularly in the A_1 horizon, the physical character and thickness of the various horizons do not vary significantly within a series. Such characteristics include colour, structure, organic matter content, reaction, and texture with the exception of the A_1 horizon.

The soil type is the principal unit of mapping and is the most specific in character of any of the units. A soil series may consist of one or more types differentiated on the basis of texture. Hence, a soil type name consists of a series name plus the textural class name determined principally from the texture of the A horizon. Although the soil type is the lowest category of separation and the most specific unit recognized in mapping soils it should be pointed out that it includes a range of conditions. The profile descriptions presented in the report do not represent a specific location but cover the conditions that occur most commonly within a delineated unit. With mapping done on the relatively small scale of one inch to the mile, it follows that through necessity a reasonable amount of variability is allowed within the mappable units. The range of characteristics tolerated within a series is discussed under the description of the various series.

A phase of a soil type is separated on the basis of those characteristics of the soil or landscape of which the soil is a part that are of importance in land use but are not differentiating characteristics of the soil profile. Such factors as proximity of bedrock, important variations in relief or stoniness are common examples of phase differences.

The Soil Series developed on similar parent material but differing in characteristics of the solum due to differences of relief or drainage are included in the soil catena. The catenary relationship of the soils of Grenville County are indicated in this report.

DIFFERENTIATION OF GRENVILLE COUNTY SOILS ACCORDING TO SOIL MATERIALS AND DRAINAGE

A. SOILS DEVELOPED FROM LIMESTONE TILL MATERIALS

I. Medium Texture

(a) Good drainage

	Acreage Mapped
(i) Brown Forest Great Soil Group	
1. Grenville loam (Grl)	29,700
2. Grenville loam, bouldery phase (Gr-b)	1,900
3. Grenville loam, shallow phase (Gr-s)	8,700
4. Grenville sandy loam (Grs)	10,200
5. Grenville sandy loam — shallow phase (Grs-s)	1,900

	Acreage Mapped
(b) Imperfect drainage	
(ii) Brown Forest Great Soil Group	
1. Matilda loam (Ml)	12,200
2. Matilda loam, bouldery phase (Ml-b)	200
3. Matilda loam, shallow phase (Ml-s)	3,000
(c) Poor drainage	
(iii) Dark Grey Gleisolic Great Soil Group	
1. Lyons loam (Ll)	5,300
2. Lyons loam, shallow phase (Ll-s)	1,300
II. Heavy Texture	
(a) Good drainage	
(i) Brown Forest Great Soil Group	
1. Wolford clay loam (Wc)	1,400
B. SOILS DEVELOPED ON POORLY SORTED SANDS AND GRAVEL	
(a) Good drainage	
(i) Grey Brown Podzolic Great Soil Group	
1. Kars gravelly sandy loam (Kg)	3,800
C. SOILS DEVELOPED ON WELL-SORTED SANDS AND SANDY LOAMS	
(a) Good drainage	
(i) Podzol Great Soil Group	
1. Uplands sand (Us)	15,800
2. Uplands sandy loam (Usl)	2,200
(b) Imperfect drainage	
(ii) Ground-Water Podzol Great Soil Group	
1. Rubicon sand (Rs)	29,600
2. Rubicon sandy loam (Rsl)	5,400
3. Rubicon sand, shallow phase (Rs-s)	400
(c) Poor drainage	
(iii) Dark Grey Gleisolic Great Soil Group	
1. Granby sand (Gs)	9,600
2. Granby sandy loam (Gsl)	24,000
D. SOILS DEVELOPED ON LACUSTRINE MATERIALS	
I. Heavy Textured	
(a) Imperfect drainage	
(i) Grey-Brown Podzolic Great Soil Group	
1. Carp clay loam (Ccl)	2,400
(b) Poor drainage	
(ii) Dark Grey Gleisolic Great Soil Group	
1. North Gower clay loam (NGc)	6,400
2. North Gower clay loam, shallow phase (NGc-s)	1,300
II. Medium Textured	
(a) Poor drainage	
(i) Dark Grey Gleisolic Great Soil Group	
1. Osgoode loam (Ol)	8,000
2. Osgoode silt loam (Os)	4,100
E. SOILS DEVELOPED ON SANDS UNDERLAIN BY CLAY	
(a) Good to imperfect drainage	
(i) Brown Podzolic Great Soil Group	
1. Manotick sandy loam (Ms)	8,300
(b) Poor drainage	
(ii) Dark Grey Gleisolic Great Soil Group	
1. Allendale sandy loam (Asl)	13,300
2. Allendale sandy loam, shallow phase (Asl-s)	800

	Acreage Mapped
F. SHALLOW SOILS OVER BEDROCK	
(a) Good drainage	
(i) Brown Forest Great Soil Group	
1. Farmington loam (F)	46,600
2. Farmington loam, depressional phase (F-i)	1,400
G. ORGANIC SOILS	
(a) Very poor drainage	
1. Muck (M)	24,600
2. Peat (P)	16,300
H. MISCELLANEOUS SOILS	
1. Bottom Land (B.L.)	4,500
2. Rock (R)	100

A. SOILS DEVELOPED FROM LIMESTONE TILL MATERIALS

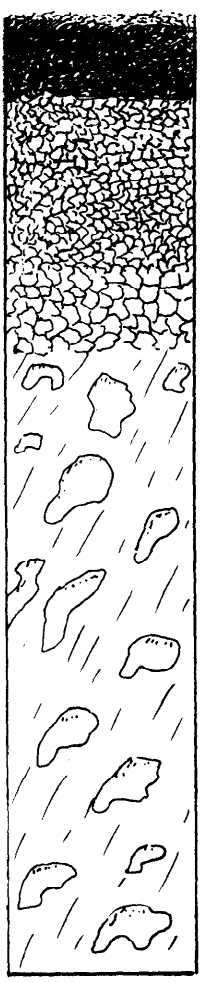
I. Medium Texture

The Grenville catena is developed on loamy limestone materials that were deposited in varying depths by the melting ice and have not been modified to any appreciable degree by lake waters. The till is composed largely of Beekmantown limestone ranging in composition from a sandy magnesian limestone to a limy sandstone. The Grenville series is the well drained member, the Matilda series the imperfectly drained member and the Lyons series the poorly drained member of the catena.

(a) *Good Drainge*

Grenville loam (29,700 acres)

The Grenville loam is a well drained, undulating to rolling limestone till soil. It occurs scattered throughout the County, the greatest expanse being in Oxford and South Gower Townships. The profile exhibits the characteristics of the Brown Forest Great Soil Group. Occasionally weakly developed Grey-Brown Podzolic profiles are found in association with the Brown Forest profiles. However, since the Brown Forest profiles predominate, the Grenville series is placed in that Great Group. The following description refers to a profile located in Oxford Township and developed under a hardwood vegetation.



A_0 and A_{00} — Thin mat of partially decomposed leaves and twigs.

A_1 — 3½ inches dark grey-brown (10YR3/2) loam; small granular structure; very friable consistency; few stones; pH — 6.3.

B_1 — 8 inches light yellow-brown (10YR6/4) loam; very fine platy structure; friable consistency; stony; pH — 6.1.

B_2 — 3½ inches (10YR5/3) loam; medium nuciform structure; friable consistency; stony; pH — 6.8.

C_1 — Grey (10YR5/1) limestone loam till; frequent stones and limestone fragments; pH — 7.8.

The topography of Grenville loam is usually moderately rolling. Occasionally fairly steep slopes occur but for the most part they are short and fairly gentle. Both the external and internal drainage are good except on the steeper slopes where the drainage is occasionally excessive. Between the ridges and at the foot of the slopes seepage areas sometimes exist that are imperfectly drained. On a larger scale of mapping, such areas would be separated out as another catenary member, but the inch to the mile scale of mapping necessitates including them with the well drained member. Stones occur throughout the profile, occasionally in sufficiently large numbers to interfere with cultivation. Although the type is susceptible to sheet erosion, it has not suffered noticeably from this menace.

Much of the Grenville loam has been cleared and the present forested areas are usually confined to small woodlots. Beech and maple occur in largest numbers with basswood, birch and ironwood occurring in lesser amounts.

Agriculture

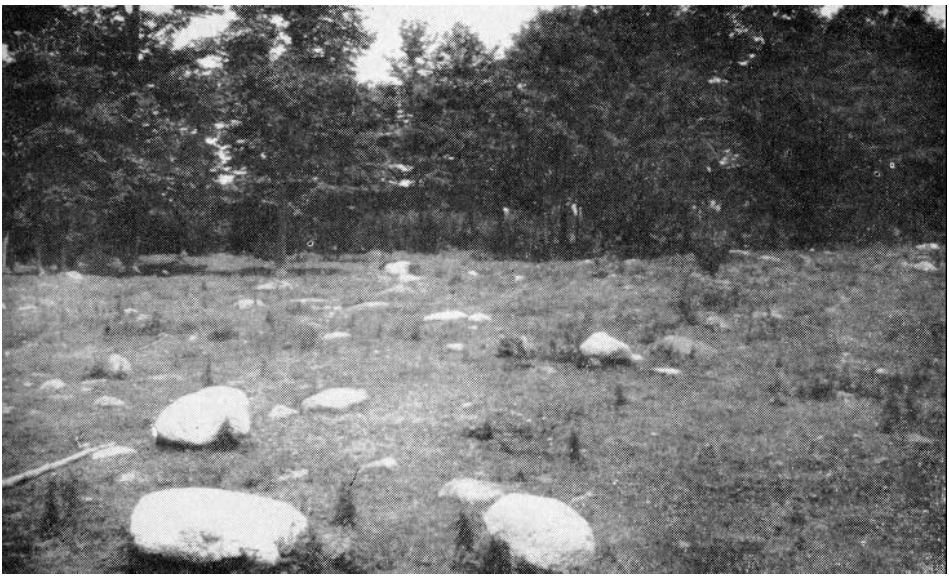
At one time the Grenville loam supported valuable stands of hardwoods, but under present conditions it is used largely as cultivated land. General farming and dairying are the chief agricultural endeavours found on these soils. It is well adapted to the growing of cereal grains, corn and legumes.

The loamy texture, and porous parent material permit early cultivation. Possibly the greatest hazard to cultivation is the large number of stones that occur within the profile.

The type is well supplied with lime and suited to the growing of legumes. This is particularly significant since dairying is an important industry and large amounts of forage crop materials are used. Although the till soils are susceptible to water erosion, the basis for a sound conservation program is already provided in the suitability of the soils to produce forage crops for the dairy herds. The dairy herds in turn provide large quantities of barnyard manure that are used to very good advantage in maintaining the organic matter content of the soils. Short rotations should be discouraged, since too frequent cultivation would increase the erosion hazard and impair soil structure.

Grenville loam, bouldery phase (1,900 acres)

Occasionally stones and boulders occur in the surface soil in sufficiently large numbers to prohibit cultivation. Usually it would not be economically feasible to attempt to remove the stones, firstly, because of the cost involved and secondly, because of the tendency for the stones in the underlying layers to become exposed at the surface. Such areas have been left in pasture land where they possibly are serving their greatest usefulness. The soil is well supplied with lime and should produce satisfactory forage crops. The bouldery phase, as the name implies, is not as versatile or valuable a type as the Grenville loam.



Stones and boulders occur in sufficiently large numbers to prohibit cultivation on the Grenville bouldery phase. These soils serve their most useful purpose as pasture land or under tree cover.

Grenville, shallow phase (8,700 acres)

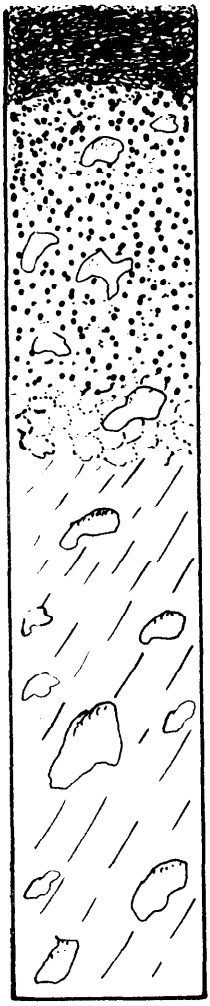
Where till deposits occur in association with limestone bedrock plains fairly extensive areas of shallow till soils are found. Bedrock usually occurs at depths ranging from one to three feet. These shallow deposits have been delineated and indicated on the map as a shallow phase of the Grenville loam. The closeness of the bedrock makes this phase much more susceptible to droughts than the deeper Grenville loam. It responds readily to light summer showers and in normal seasons produces fair crops. However, it is to be expected that the presence of the bedrock does limit its usefulness. Because the profile characteristics are similar to those of the Grenville loam, it was felt, these areas could be best correlated as a phase of that type.

The vegetation is similar to that found on the Grenville loam. Even on the shallow till deposits, hardwoods take precedence over the conifers found on the limestone bedrock plains (Farmington). Several sugar camps are 1ocated in the maple woodlots in the County. The Grenville shallow phase is frequently used as pasture land and since it is deeper than the Farmington with which it is associated, it provides forage later in the summer season than the very shallow soils.

Grenville sandy loam (10,200 acres)

The Grenville sandy loam differs from the loam in that there is a layer of sandy loam materials of varying depths overlying the loamy Beekmantown till. Occasionally the underlying till is quite sandy. There is a general tendency for the sandy loam to be more deeply weathered than the loam.

The following is a generalized description of a Grenville sandy loam profile:



A_C — 5 inches greyish brown (10YR5/2) sandy loam; fine crumb structure; friable consistency; few stones; pH — 6.8.

B_1 — 15 inches yellowish brown (10YR5/4) sandy loam; very weak platy to single grain structure; friable consistency; few stones; pH — 6.6.

B_2 — 3–4 inches brown (10YR5/3) sandy loam; weak to medium nuciform; friable consistency; pH — 6.8.

C — Stony, grey (10YR5/2) sandy loam and loam till; frequent limestone bedrock fragments; pH — 7.8.

The topography is strongly undulating to rolling. Both internal and external drainage are good. The tree growth is similar to that of the Grenville loam with a slightly greater proportion of conifers. Sheet erosion has not affected the type noticeably but it has suffered slightly from wind erosion. Stones are found throughout the profile but for the most part do not occur in sufficiently large numbers to interfere with cultivation.

Agriculture

The cultivated crops grown on this type are similar to those found on the Grenville loam, but the yields obtained are usually somewhat lower. Because of the coarse textured materials the Grenville sandy loam has been more severely leached than the loam resulting in lower fertility levels. The Grenville sandy loam is an early soil in the spring which gives it an advantage over some of the heavy textured types. It is fairly well suited to the growing of fodder corn, turnips and potatoes. Only fair crops of cereal grains, legumes, and pasture are produced on this type.

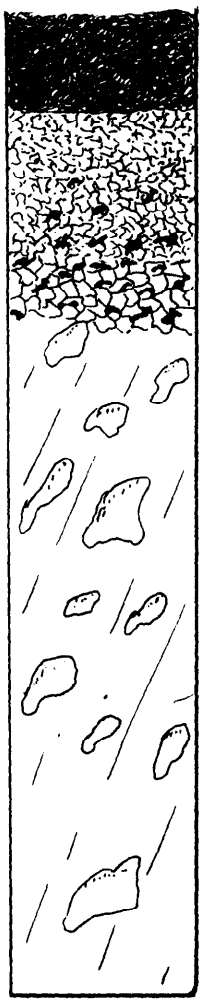
Grenville sandy loam, shallow phase (1,900 acres)

In the Grenville sandy loam, shallow phase, bedrock occurs at depths of three feet and less. The profile characteristics are similar to the Grenville sandy loam. The shallow type is more susceptible to drought and is not as reliable as the deeper sandy loam type.

(*b*) *Imperfect Drainage*

Matilda loam (12,200 acres)

The Matilda loam is the imperfectly drained member of the Grenville catena. Developed on limestone till materials it is usually mapped in association with the Grenville loam. Occurring between ridges of Grenville loam the type is imperfectly drained and the underlying till occasionally contains pockets of lacustrine material. The textural and colour horizons are poorly defined and the profile exhibits characteristics of a weakly developed Brown Forest soil. A commonly occurring Matilda loam profile exhibits the following characteristics:



A_c — 0–6 inches dark grey-brown (10YR4/2) loam; fine granular structure; friable consistency; few stones; medium organic matter; pH — 7.0.

B_1 — 8 inches brown (10YR5/3) loam; slightly mottled; coarse granular structure; friable consistency; pH — 6.8.

B_2 — 3–4 inches loam; slightly darker in chroma and more highly mottled than the B_1; weak nuciform structure; friable consistency; horizon relatively indistinct and not always present; pH — 7.0.

C — Greyish (10YR5/1) calcareous till; many limestone fragments; occasionally contains a fair amount of finer lacustrine material intermixed with it; pH — 7.8.

The effect of the undulating to level topography is reflected in the imperfect external and internal drainage. Stones occur in varying quantities, often reaching proportions where cultivation is made impossible. There has been practically no erosion on the type. The tree growth consists of elm, soft maple, hemlock and birch.

Agriculture

A fairly large proportion of the Matilda loam is used for pasture land, with considerable areas remaining under tree cover. Since it occurs in association with the Grenville loam, it is frequently left as pasture areas and the better drained type is used for growing cultivated crops. It does not occur in large expanses, since it is usually found between the swells of the well drained soils or at the foot of the slopes. Occasionally bedrock occurs at shallow depths and when such a condition exists, the area is usually used for permanent pasture purposes.

When Matilda loam is cultivated, the number of crops that can be grown on it is smaller than on the Grenville loam. Cereal grains do fairly well, but legumes, particularly alfalfa, are not tolerant of the imperfect drainage conditions. A fairly large acreage is used for buckwheat and hay crops. The organic matter content is medium and the type is well supplied with lime. It should respond to improved drainage conditions but the cost of installation might be high because of the difficulty in procuring outlets.

Matilda loam, bouldery phase (200 acres)

There are a few small areas of Matilda loam in the County where stones occur in sufficiently large numbers to make cultivation practically impossible. The bouldery phase of the Matilda is usually used for pasture land. The excessive stoniness makes pasture renovation very difficult.

Matilda loam, shallow phase (3,000 acres)

The profile characteristics of the Matilda loam, shallow phase, are similar to those of the Matilda loam. Bedrock usually occurs at depths of three feet and less. The proximity of the bedrock limits the usefulness of these soils. Provided climatic conditions are satisfactory fair yields of crops are produced. The soils mapped as the shallow phase are less reliable and suffer more extensively from seasonal difference than the deeper soils.

(c) Poor Drainage

Lyons loam (5,300 acres)

Lyons loam is mapped in association with the Matilda and Grenville soils and usually occurs in level to depressional areas. It is the poorly drained member of the Grenville catena. The Lyons series has been mapped in most counties in Ontario as a poorly drained limestone till soil. Hence, it occurs in several catenas under our present system of classification. The profile is belongs to tne Dark Grey Gleisolic Great Soil Group and exhibits the following characteristics:

A_c — 0–7 inches very dark brown (10YR2/2) loam; coarse crumb structure; friable consistency; stony; pH — 7.2.

G_1 — 7–15 inches greyish brown (10YR5/2) loam; massive structure; friable consistency; stony; pH — 7.2.

C — Grey (10YR5/1) calcareous till; stony; pH — 7.8.

Often the surface soil is excessively stony. Fairly extensive areas occur in association with the limestone bedrock plains, and it is not unusual for bedrock to occur at depths of less than three feet. Free carbonates usually occur on the surface.

Because of its topographic position the natural drainage is poor. This condition is often aggravated by seepage from the surrounding higher land. Where the materials are sufficiently deep the type should respond to drainage by large open ditches. Such ditches would often be difficult to construct because of the proximity of bedrock and the presence of numerous large boulders.

A large proportion of the Lyons remains in woodland, where the most frequently occurring trees are white cedar, spruce, soft maple, hemlock, birch, alder, willow and elm. Areas not in woodland are often used for pasture land. When cultivated it is a late soil in the spring and even at the best only fairly well suited to the production of cereal grains. The poor drainage makes it ill-suited for the production of legumes. Timothy, hay and permanent pasture do fairly well and fair yields of buckwheat are obtained.

Lyons loam, shallow phase (1,300 acres)

When the bedrock occurs at depths of three feet and less, the Lyons loam, shallow phase, is mapped. Shallowness along with poor drainage limits the usefulness of these soils. Usually they are used for pasture or woodland.

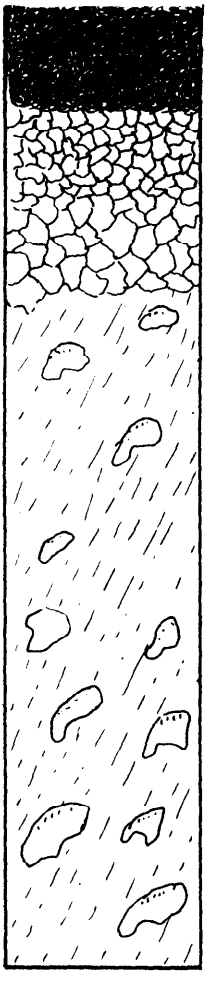
II. Heavy Texture

In the northwest corner of Wolford Township a fairly broad expanse of medium to heavy textured soils occur. The materials consist of a mixture of limestone till intermixed with heavier lacustrine materials similar to those of the Carp catena. The deposition of materials has been variable, ranging from a condition where the till is covered with lacustrine materials in the undulating areas between the swells, to the knolls where it breaks through the lacustrine veneer and is exposed on the surface. The presence of the till materials allows for fairly free movement of water through the profile and has facilitated internal drainage. On the well drained sites a weakly developed Brown Forest profile has developed. The type is fairly well supplied with lime, free carbonates commonly occurring in the underlying till. The dual deposition of till and lacustrine materials has resulted in a type of soil that presents more favourable characteristics than soils found on either the Grenville or the Carp series. The type lacks the stoniness of the Grenville and is better supplied with plant nutrients while the internal drainage is more favourable than that of the Carp Series.

(a) Good Drainage

Wolford clay loam (1,400 acres)

Only 1,400 acres of Wolford clay loam were recognized and mapped in Grenville County. Found, for the most part, in the northwest corner of Wolford Township, the Wolford clay loam occurs on undulating to rolling topography. Formed from till deposits, intermixed with lacustrine materials, the type exhibits Brown Forest characteristics. A profile examined south of the village of Easton's Corners exhibited the following characteristics:



A_c — 6 inches dark grey (10YR4/1) clay loam; fine to medium granular structure; friable consistency; occasional stones; pH — 6.8.

B_1 — 6 inches weak yellowish brown (10YR5/4) clay loam; fine nuciform structure; friable consistency; occasional stones; pH — 6.6.

B_2 — 5 inches dark yellow-brown (10YR4/3) clay loam; medium nuciform structure; friable consistency; stony; pH — 7.0. (This horizon is better defined by structure than colour.)

C — Heavy, grey (10YR7/2) limestone till intermixed with lacustrine materials; weak blocky structure; tony; pH — 7.8.

There is a fairly wide variation in the types of profiles found on the Wolford clay loam depending on the depth of lacustrine veneer over the till. The amount of stones found throughout the profile is variable. Between the swells or rolls the profile is more poorly developed and often is imperfectly drained. The Wolford clay loam mapped in Dundas County lacks the wide variability and is more uniformly a true Brown Forest soil than that which occurs in Grenville County. These soils have developed under vegetation similar to that on the Grenville Series, namely hard maple and beech with elm appearing at the foot of slopes and in depressional areas. The type has not suffered greatly from sheet erosion and chemical tests show it to be fairly well supplied with plant nutrients.

Agriculture

The Wolford clay loam is well suited to dairy farming and some very good farms have been established on this type. Most farm crops commonly grown in Grenville County are produced with reasonably good success. The type appears to be well adapted to the growing of cereal grains, hay and pasture.

The internal drainage and supply of plant nutrients is sufficiently good to permit the growing of alfalfa and other legumes. Where dairy farming is practised, the use of forage crops and barnyard manure provides the basis for an effective and sound erosion control program. A large proportion of the type has been cleared and is in regular crop rotation. Occasionally it may be necessary to improve the drainage conditions between the ridges, but this does not present as great a problem as is found in some of the other types mapped in the County.

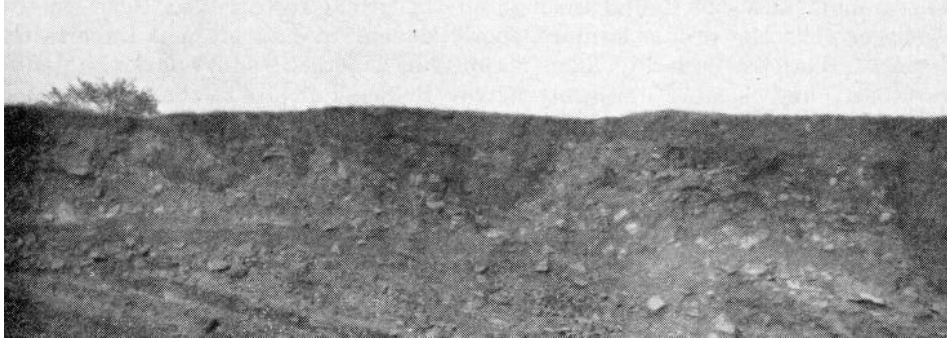
B. SOILS DEVELOPED ON POORLY SORTED SANDS AND GRAVELS

The materials on which the soils of this group developed were deposited by fluvio-glacial action. Unlike similar materials in Carleton County they do not occur as continuous ridges but assume fan-like shapes. There is a fairly extensive area in South Gower Township and another one in Oxford Township. The underlying materials consist of poorly sorted sands and gravels of medium to low lime content.

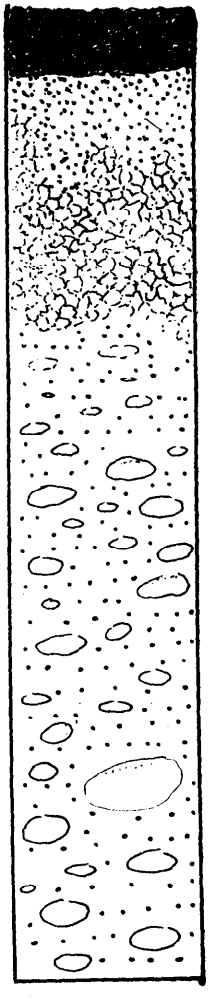
(a) Good Drainage

Kars gravelly sandy loam (3,800 acres)

The Kars gravelly sandy loam is the only catenary member recognized and mapped. For the most part it exhibits Grey-Brown Podzolic characteristics, although occasionally the A_2 horizon is very thin. Often the weathered portion of the profile appears to be masked with a yellowish brown colour. Neither the colour or textural differences between the A_2 and B horizons are well defined. Since considerable variation is found in the type of profile that occurs on the poorly sorted gravelly materials, it is well to consider these soils as transitional between the Grey-brown Podzolic and Brown Forest soils with a closer resemblance to the former.



Weak Grey-Brown Podzolic profiles are found on the Kars gravelly sandy loam.



A_c — 5 inches dark greyish brown (10YR4/2) gravelly sandy loam; very fine crumb to single grain structure; extremely friable consistency; stony; pH — 6.4.

A_2 — 2–8 inches yellowish brown (10YR5/4) sandy loam; single grain structure; extremely friable consistency; stony; pH — 6.4.

B_1 — 6 inches dark brown (10YR4/3) sandy loam; weak granular structure; very friable consistency; stony; pH — 6.8.

B_2 — 6 inches dark brown (10YR4/3) loam (slightly darker in colour than previous horizon); weak granular structure; friable consistency; stony; pH — 6.8.

C — Poorly sorted sands and gravel containing a fair proportion of carbonates; pH — 7.2.

The Kars gravelly sandy loam is a light textured excessively drained soil developed on undulating to rolling topography. Although most of the area mapped has been cleared, it would appear that the Kars soils developed under a tree cover of maple, beech and pine. The surface soil when cultivated is light greyish brown sandy loam, low in organic matter. The type is comparatively low in the nutrients, phosphorus and potassium.

Agriculture

The Kars because of the porous nature of the materials permits early spring cultivation. In some areas, particularly in Oxford Township, stones ranging up to boulder size occasionally occur in the surface soil. They do not occur in sufficient quantities to prohibit cultivation and so do not influence land use to the same extent as in the stony areas of the Grenville series. A large proportion of the Kars series remains in pasture land. The type is well suited to the production of row crops, corn and potatoes, provided fertility

levels are maintained. The organic matter content is low and a soil management system that makes provision for the building up and maintenance of this important component should be encouraged. Because of low fertility levels, the type is only fairly well suited for the production of cereal grains, hay and pasture.

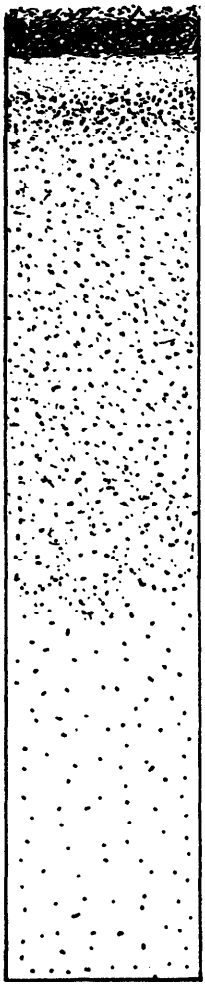
C. SOILS DEVELOPED ON WELL-SORTED SANDS AND SANDY LOAMS

A large proportion of the soils of Grenville County has developed on well sorted sandy materials deposited by still or slowly moving water. Occasionally the materials consist of gravel but when such a condition occurs there is usually a veneer of sandy materials overlying them. The materials usually have a low lime content and are stonefree. In the southeastern section of Edwardsburg Township, there are small and scattered areas included with this low lime group of oils in which the underlying materials effervesce freely with dilute acid. The Uplands catena has developed on the well sorted sand and sandy loam materials. The lime content of the well drained member is lower than that of the imperfectly and poorly drained members because of more intense leaching.

(a) *Good Drainage*

Uplands sand (15,800 acres)

The Uplands series is the well drained member of the catena. Developed on low lime materials and under a dominantly coniferous vegetation, it exhibits a well developed podzol profile. The following is a description of a profile developed under coniferous vegetation.



A_0 — Very thin mat of partially decomposed leaf litter.

A_1 — 2 inches very dark grey (10YR3/1) sand; single grain to weak crumb structure; extremely friable consistency; pH — 5.8.

A_2 — 1½ inches grey (10YR7/2) sand; single grain structure; extremely friable consistency; pH — 5.2.

B_2 — 2 inches drak brown (10YR4/4) sandy loam; single grain to fine nuciform structure; weakly cemented; friable consistency; pH — 6.2.

B_3 — 36 inches brownish yellow (10YR6/6) sandy loam; single grain structure; very friable consistency; pH — 6.2.

C — Grey (10YR7/1) sand; frequently well sorted; pH — 7.0.

The topography ranges from gently undulating to strongly rolling. Internal drainage is excessive and on the more rolling areas there is considerable surface runoff. Because of the low fertility level and the rather scanty vegetative cover generally found on this soil, it is susceptible to wind erosion. In a previous survey in Grenville County, the eroded areas were separated out as Bridgman sand. Since the time of that survey, new areas have been eroded and other previously eroded areas have been reforested. At the present time, many of the knolls in the Uplands sand areas have been denuded of their surface soil and vegetative cover. On the inch to the mile scale of mapping, it was impossible to show these on the map. Hence, the Uplands sand includes a range of conditions, from a well developed podzol profile to wind eroded areas where the weathered profile has been entirely removed.

The vegetative cover produced on this Uplands sand has not been sufficiently dense to hold the oils in place. Reforestation is recommended for severely wind eroded areas.

The type developed under a coniferous forest cover in which Jack and red pine were dominant. The cultivated surface soil is commonly very low in organic matter and chemical tests indicate that the levels of available plant nutrients are very low.

Agriculture

The use of Uplands sand for the production of agricultural crops is limited by its low moisture holding capacity and low fertility levels. A large proportion of this type is left in pasture land where only a scanty and mediocre vegetative cover is produced. Provided fertility levels and organic matter content are raised and satisfactory climatic conditions prevail, fair crops can be obtained from this type. The type is not well suited to the production of either pasture or grain crops and would probably serve a more useful purpose if devoted to specialized crops such as early potatoes, where the value of the crop produced would permit fairly large expenditures for commercial fertilizers. Since the Uplands sand has suffered fairly extensively from wind erosion the control of this hazard merits attention. This soil is well suited to the production of pine and the planting of trees is probably the quickest, and most effective means of arresting wind erosion.

Uplands sandy loam (2,200 acres)

Only a comparatively small acreage of Uplands sandy loam occurs in Grenville County. The profile characteristics are similar to the sand type, the chief difference being the heavier texture and higher colloidal content of the sandy loam which is reflected in the greater moisture holding capacity and suitability for the production of general farm crops. Wind erosion has not seriously affected it and some fairly good farms are located on the Uplands sandy loam.

(b) *Imperfect Drainage*

Rubicon sand (29,600 acres)

The Rubicon sand occupies slightly over 10 per cent of the land area of Grenville County. It has developed on low lime, stonefree, sandy materials of variable moisture relationships. This type has also been mapped in south-central Ontario where the lime content of the underlying material is much higher than that in Eastern Ontario. It is impossible to describe a profile that would be applicable to the type in general. The topography is variable, ranging from depressional areas to rolling knolls. Although the Rubicon is considered the imperfectly drained member of the Uplands catena, it includes profiles representative of the poorly drained member in the depressions and the occasional well developed podzol, representative of the well drained member, on the knolls. The most commonly occurring profile is a ground-water podzol that exhibits the following characteristics. The profile described below is situated in a cut-over forested area where pine, poplar and elm formed the tree cover.

A_0 — 1–1½ inches mat of leaf litter.

A_1 — 1–1½ inches very dark grey (10YR3/1) sandy loam; single grain structure; very friable consistency; stonefree; pH — 6.2.

A_2 — 6 inches grey (10YR7/2) sand; single grain structure; stonefree; friable consistency; pH — 5.8.

B_2 — 6 inches dark brown (10YR4/3) loamy sand; single grain structure; hard consistency; stonefree; pH — 6.0.

B_3 — 12 inches brownish yellow (10YR6/6) sand; single grain structure; hard consistency; intensely mottled; stonefree; pH — 6.0.

C — Grey (10YR7/2) sand and gravel; stonefree; pH — 6.0.
(Carbonates occasionally occur in the C horizon.)

D — Clay occurs at depths of three feet and more.

The above description would apply to about 50–60 per cent of the area mapped as Rubicon sand.

As has been indicated earlier, the topography and drainage conditions are variable. Erosion occurs on the excessively drained included knolls.

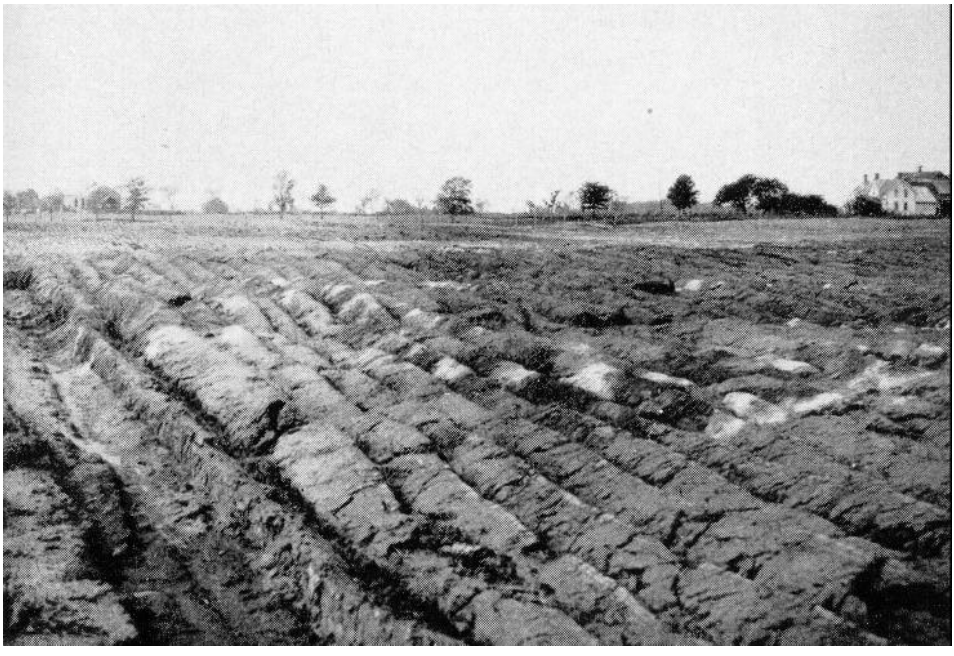
Agriculture

A fairly large proportion of the type still remains in woodland. Long term pasture land occupies a considerable percentage of the cleared area, while dairy farming is the chief agricultural endeavour found on the cultivated areas of Rubicon sand. The land use varies according to the relative proportions of well, imperfect and poorly drained profiles. Where extensive, uniform imperfectly drained areas occur general farming is conducted. In areas where the poorly drained depressional areas dominate the land is frequently used for pasture and woodland. The greater depth of sand and the open nature of the materials makes the retention of soil moisture rather difficult on the knolls. Improving the drainage in the depressional areas frequently aggravates the excessive drainage condition of the knolls. Drainage improvement on such areas is often further complicated by difficulty in obtaining outlets and the occurrence of clay layers at shallow depths.

Chemical tests indicate that the Rubicon sand is low in practically all plant nutrients. The organic matter content is variable. For the most part the surface soil is quite acid and should respond to liming. It is only fairly well suited to the production of most farm crops, being limited by both unsatisfactory drainage and fertility conditions. Dairy farming appears to be the agricultural endeavour for which the soil is best suited. Under such a system the better areas could be used as cropland and the more imperfectly and poorly drained sections reserved for pasture land. In the adjoining county of Carleton, potatoes are grown on this type with a fair amount of success. The acreage of this crop on the Rubicon in Grenville County is very small.

Rubicon sand, shallow phase (400 acres)

Where bedrock occurs at depths of three feet and less a shallow phase of the Rubicon sand is mapped. The closeness of bedrock combined with low fertility levels make these soils poorly suited for the production of crops commonly grown in the area.



Note the undulating topography of the Rubicon sandy loam. The grey, highly leached podzol layer is showing on the knolls while the surface soil in the depression is very dark grey in colour.

Rubicon sandy loam (5,400 acres)

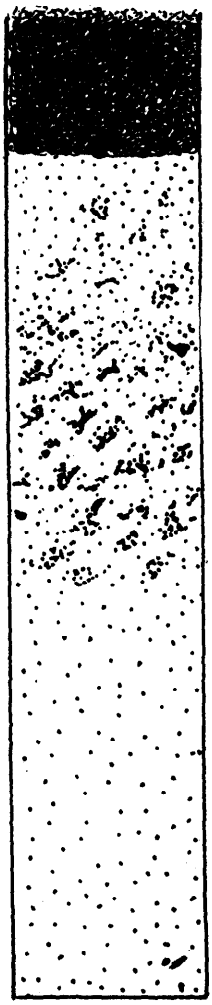
The variability within the sandy loam type is similar to the sand, the greatest difference between the two types being in the texture of the surface soil. The finer texture and greater colloidal content of the sandy loam combine to make it a more productive and valuable soil. However, its use for agricultural purposes is still limited by the lack of uniform and adequate drainage. Some fairly prosperous dairy farms are located on the Rubicon sandy loam in the southern section of the County, particularly when the type occurs in extensive, uniform, undulating areas. With sound soil management practices, farming endeavours appear to be quite successful. On most areas lime and heavy applications of commercial fertilizer are required for the production of legumes. Areas left to permanent pasture usually contain a vegetative cover largely dominated by Redtop and Canada Blue grass. There appears to be a place for an effective pasture improvement program on this soil type.

(c) Poor Drainage

Granby sandy loam (24,000 acres)

The Granby series occurs in level to depressional areas and is the poorly drained member of the Uplands catena. A Dark Grey Gleisolic type of profile has developed in which it is difficult to observe the horizon differentiation. Occupying slightly less than 10 per cent of the area, it occurs in all the townships with large expanses being found in South Gower and Edwardsburg. The original tree cover under which this type developed consisted of elm, soft

maple, balsam and spruce with some white cedar. The following is a description of a Granby sandy loam profile occurring under natural forest cover:



A_0 — Thin mat of leaf litter.

A_1 — 8 inches very dark grey (10YR3/1) sandy loam; crumb structure; very friable consistency; stonefree; pH — 6.2.

G_1 — 10 inches grey (10YR6/1) sand and sandy loam; single grain structure; very friable consistency; stonefree; pH — 6.0.

G_2 — 15 inches brownish grey (10YR6/2) sand; low contrast brown (10YR5/3) mottles; single grain structure; friable consistency; stonefree; pH — 6.9.

C — Well-sorted stratified grey (10YR7/2) sand and gravel; carbonates occasionally occur; layers of finer textured silt and clay occasionally appear in the profile at fairly shallow depths. pH — 7.2.

Level to depressional topography and poor drainage are the dominant characteristics of this type. The profile is stonefree and the surface soil is usually fairly high in organic matter and exhibits a dark colour. In South Gower Township the type is mapped in association with the Osgoode series and consequently strata of heavier materials occasionally occur at shallow depths or as lenses throughout the profile. The type would respond to drainage improvement, particularly to wide and deep open ditches, but outlets are often difficult to obtain.

Agriculture

A large proportion of the Granby sandy loam remains in woodland or pasture. Poor drainage results in late spring cultivation so that it is often too late to plant any cereal grains except buckwheat. Areas in pasture land

support only mediocre stands of grasses, usually consisting of Redtop and Canada Blue. Scrub tree growth is establishing itself on areas that have reverted to pasture, thus lessening their usefulness for the production of forage.

Where drainage improvement has been effected, fair crops of cereal grains, hay and pasture are produced. When the soil is cultivated, the organic matter should be maintained to assure adequate moisture conservation. Once the required drainage is effected, fertility must be maintained because the reserve supply of nutrients is not high.

Granby sand (9,600 acres)

The profile characteristics of the Granby sand are similar to those of the sandy loam type with the exception of texture. The coarser texture increases the soil management problems found on the lighter type. Much of the sand is in pasture and scrub tree growth. Lower in plant nutrients than the sandy loam, once it is drained and cultivated, fertility maintenance is of prime importance. The sand and sandy loam types often occur in association with one another and it is difficult to separate them on an inch to the mile scale of mapping. Being a late soil, when cultivated it is used largely for the production of hay, pasture or buckwheat.

D. SOILS DEVELOPED ON LACUSTRINE MATERIALS

I. Heavy Texture

The Carp catena has developed on greyish, silty clay loams with medium lime content. The heavy lacustrine deposits do not occur in broad expanses in Grenville County and are usually found in close proximity to the main drainage channels. It is possible the materials owe their origin to the waters of the Champlain Sea and were probably later modified by local pondings. Coleman* reports interglacial marine shells to have been found at Norwood near Ogdensburg in St. Lawrence County, New York. The reaction of the surface soil is about neutral. Free carbonates commonly occur in the parent material.

Only two members of the Carp catena were recognized and mapped in Grenville County. The Carp, the imperfectly drained member, exhibits rather weakly defined horizons and might be best correlated as a weakly developed hydromorphic associate of the Grey-Brown Podzolic soils. The poorly drained member, the North Gower series, has developed under very high moisture conditions and is a typical member of the Dark Grey Gleisolic Great Soil Group.

(a) Imperfect Drainage

Carp clay loam (2,400 acres)

The Carp clay loam occurs for the most part along stream courses, particularly along the Rideau River. Gently undulating topography and moderate to slow drainage are characteristic of the type. The following generalized description of a profile indicates its characteristics:

*Coleman, A. P. The Last Million Years; The University of Toronto Press, Toronto, 1941.

A_0 — ½ inch thin mat of leaf litter.

A_1 — 5 inches dark grey-brown (10YR4/2) clay loam; medium granular structure; friable consistency; stonefree; pH — 6.6.

A_2 — 6 inches light brownish grey (10YR6/2) clay loam; weak, medium nuciform structure; friable consistency; stonefree; pH — 6.4.

B_2 — 4 inches brown (10YR5/3) clay loam; horizon poorly defined; weak, medium blocky structure; hard consistency; slightly mottled; stonefree; pH — 6.8.

B_3 — 15 inches mottled grey-brown (10YR5/2) clay loam; massive structure; stonefree; plastic consistency; pH — 7.2; (free carbonates sometimes present).

C — Grey (10YR6/1) clay and silty clay; massive structure; plastic consistency; occasionally varved; sometimes grit present; carbonate content medium; pH — 7.3.

Most of the Carp clay loam has been cleared and is now under cultivation. The tree cover appears to have been dominated by elm, ash and soft maple with the occasional hard maple. The internal drainage is slow but often there is sufficient fall towards the stream courses to permit adequate external drainage. The type has not suffered noticeably from sheet erosion but gully erosion may require control measures particularly along stream courses. The type is only moderately variable, the profile being better developed and the horizons more clearly defined on the better drained sites, particularly along the St. Lawrence River in Augusta Township. The Carp clay loam is occasionally mapped in association with the outwash sand. Where the sand occurs as a uniform deposit over the underlying heavier material it was separated as a different series, the Manotick sandy loam. However, in the northern part of the County a small area occurs where only small patches of sand are left, too small to be indicated on the map. These areas have been indicated as a sand spot phase (Cc-s). This condition does not occur extensively.

Agriculture

There are not many farms located entirely on the Carp clay loam. Since the series frequently occurs in association with sandy materials and limestone till plains, the farms are usually included on two or more series. The Carp clay loam is well suited to dairy farming which is the most common agricultural endeavour found on it. It is also well suited to the production of small grains, corn, hay and pastures. Alfalfa can be produced with fair success on the better drained portions.

The organic matter content is medium and is well incorporated with the mineral portion of the soil. Chemical tests show the Carp series to be fairly well supplied with plant nutrients. Productivity can be fairly well maintained through the use of good farm practices.

(b) Poor Drainage

North Gower clay loam (6,400 acres)

The North Gower clay loam is the poorly drained member of the Carp catena. Developed on materials similar to those of the Carp series, it occurs on level to depressional topography under high moisture conditions. The horizons of the profile are poorly defined as indicated by the following description:

A_0 — Mat of leaf litter.

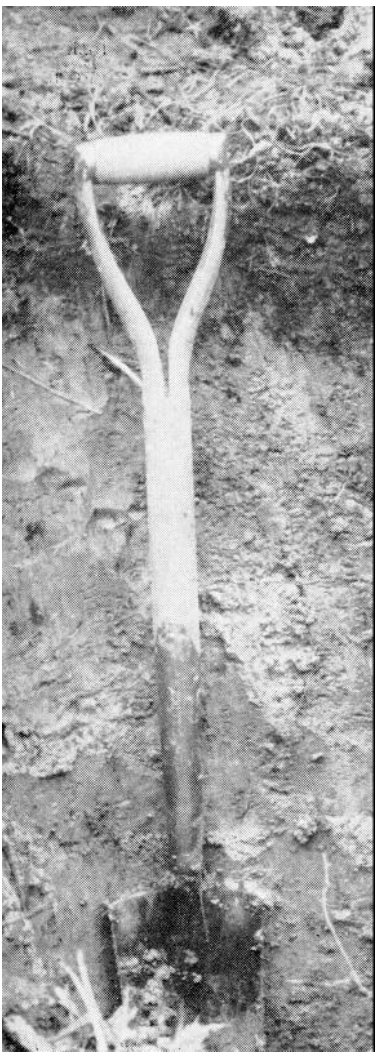
A_1 — 7 inches very dark grey (10YR3/1) clay loam; medium granular structure; friable consistency; stonefree; pH — 7.0.

G_1 — 4 inches dark grey (10YR5/1) clay loam; weak blocky structure; mottled; plastic consistency; stonefree; pH — 7.0.

G_2 — 15 inches dark grey (10YR5/1) clay loam; intensely mottled; coarse blocky structure; plastic consistency; stonefree; pH — 7.2.

C — Grey (10YR6/1) clay; massive structure; occasionally some grit; free carbonates present; pH — 7.4.

The tree cover of the North Gower consisted largely of elm, ash and soft maple. The organic matter of the surface soil is well incorporated with mineral matter. Chemical tests show the type to be fairly well supplied with most plant nutrients, the chief limitation for crop production being the poor drainage conditions.



The North Gower clay loam belongs to the Dark Grey Gleisolic Great Soil Group. Note the dark surface horizon underlain by a mottled, grey glei layer.

This picture shows the structura aggregates from the A_1, G_1, G_2 and C horizons of a North Gower clay loam profile. The aggregates increase in size in the lower horizons.

Agriculture

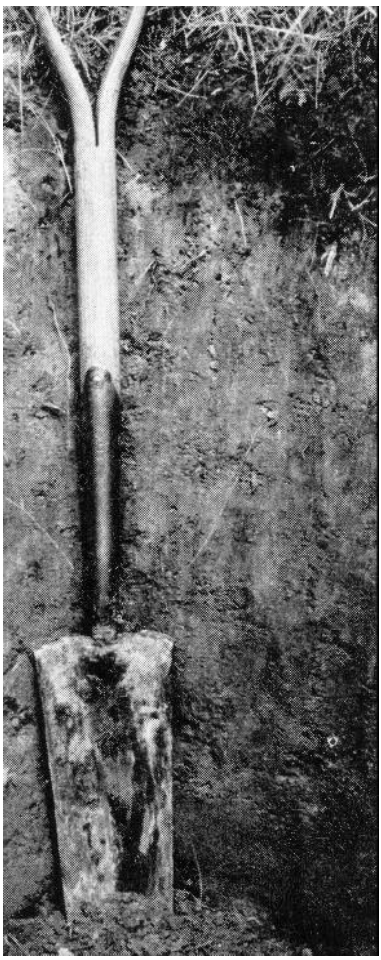
General farming and dairying are the most, common agricultural endeavours found on the North Gower clay loam. Poor drainage practically prohibits the growing of alfalfa. Provided weather conditions permit reasonably early planting, good yields of cereal grains are obtained. The type is well suited to the production of hay and pasture. Drainage conditions are the chief iimitations for agricultural production on the North Gower clay loam.

North Gower clay loam, shallow phase (1,300 acres)

Where bedrock occurs at depths of three, feet and less the North Gower clay loam, shallow phase, is mapped. The closeness of the bedrock makes the soil less reliable and more susceptible to variations in weather conditions.

II. Medium Texture

The materials contained in this group are lighter in texture than those discussed previously. They occur in fairly extensive areas in the northern portion of South Gower and Oxford Townships and to a lesser extent in the remaining townships of the County. The deposition can probably be explained by a mixing of coarser materials from sand and gravel ridges with heavy



The Osgoode loam is a poorly drained, medium textured soil. Provided wet seasons do not interfere with spring planting, it produces good yields of general farm crops.

lacustrine deposits. This explanation appears feasible, particularly in consideration of the irregularity of the layering that commonly occurs within the materials. The parent materials contain medium amounts of lime. The medium textured materials are usually underlain by clay at depths of three feet and greater. Only the poorly drained catenary member, the Osgoode, has been mapped thus far.

The profile is poorly developed and exhibits the hydromorphic characteristics associated with the Dark Grey Gleisolic soils.

(a) *Poor Drainage*

Osgoode loam (8,000 acres)

The topography of the Osgoode loam ranges from level to slightly undulating. It is a neutral, stonefree soil. Developed under a tree cover consisting largely of soft maple, elm and ash, the profile exhibits the following characteristics:

A_0 — Thin mat of leaf litter.

A_1 — 5 inches very dark grey-brown (10YR3/2) loam; fine granular structure; friable consistency; stonefree; pH — 6.8.

G_1 — 6 inches mottled light brownish grey (10YR6/2) loam; coarse granular structure; friable consistency; stonefree; pH — 6.6; horizon poorly defined.

G_2 — 20 inches light brownish grey (10YR6/2) loam; intensely mottled; weak, medium nuciform structure; stonefree; friable to weakly plastic consistency; pH — 7.0.

C — Grey (10YR6/1) loam and silt loam; frequently layered; effervesces with dilute acid; pH — 7.5.

Occasionally on a better drained site there is a tendency for a weak B horizon to develop. For the most part, however, the profile is featureless and shows little clear definition of horizon development. Under natural conditions it is relatively high in organic material which has become well incorporated with mineral matter. Chemical tests show it to be moderately well

supplied with plant nutrients and if properly managed has a very satisfactory soil structure. Since it occurs in areas of level to very slightly undulating topography, it has not suffered from sheet erosion.

Agriculture

For the most part this soil is farmed intensively. However, there are still fairly large areas in woodlots and permanent pasture. Dairy farming is conducted with considerable success on the Osgoode series.

Provided weather conditions are satisfactory to permit spring planting, the type produces good yields of most farm crops. Drainage is the chief physical limitation of this soil in its natural state. Once the drainage is improved, fertility and organic matter maintenance is of greater importance than on the heavier textured soils. The type responds well to both tile draining and open ditches.

Under present conditions there has been little drainage improvement. Alfalfa does not tolerate the poor drainage and consequently the forage crops contain only a small percentage of this legume in their composition. It is well suited to the production of oats, barley, alsike, timothy and permanent pasture. Dairy farming provides a good source of organic matter and accommodates an effective soil management system for the Osgoode loam.

Osgoode silt loam (4,100 acres)

Differing from the Osgoode loam in texture, this type presents the same profile characteristics as the former. Although the nutrient levels are slightly higher, the type supports similar crops and serves about the same land use as the Osgoode loam. Occasionally heavier textured layers occur throughout the profile and in the underlying materials. When such a condition exists the drainage problem is aggravated. In South Gower Township the loam and silt loam occur in association with one another, making it difficult to show their distribution on the map. The dominant condition was mapped and indicated. When the Osgoode series occurs in association with the Grenville series a very satisfactory condition exists, the well drained knolls serving as satisfactory building sites and providing suitable land for growing those crops requiring better drainage than the Osgoode possesses.

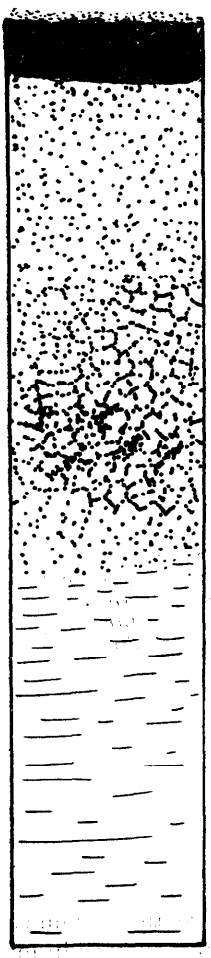
E. SOILS DEVELOPED ON SHALLOW MATERIALS UNDERLAIN BY CLAY

About 9 per cent of the Grenville County area is occupied by an overburden of sand underlain by clay. The stonefree outwash materials are similar to those of the Uplands catena, while the clay closely resembles the Carp catena materials. The depth of sand is variable, ranging from a veneer of a few inches in depth up to three feet. The variability in depth of materials makes it difficult to describe a typical profile common to these soils. Two series were mapped, the Manotick occurring on the better drained portions and the Allendale on the poorly drained areas. Where the sand deposit reaches a foot or more in depth a fair profile has developed which exhibits Brown Podzolic characteristics in the better drained positions and Dark Grey Gleisolic characteristics in the poorly drained position.

(a) *Good to Imperfect Drainage*

Manotick sandy loam (8,300 acres)

The topography of the Manotick sandy loam is undulating to gently rolling. The drainage conditions and the depth of sand over the underlying clay are variable. A wide range of profiles occurs, depending on topographic position and depth of sand overburden. Pine trees dominate on the lighter knolls, while white birch and maple are found in areas where the clay comes closer to the surface. The profile exhibits the following characteristics:



A_0 — Thin mat of leaf litter.

A_1 — 3 inches grey-brown (10YR5/2) sandy loam; single grain to fine crumb structure; extremely friable consistency; stonefree; pH — 6.6.

B_1 — 12 inches yellowish brown (10YR5/4) sandy loam; single grain structure; very friable consistency; stonefree; pH — 6.6.

B_2 — 15 inches light yellowish brown (10YR6/4) sandy loam; granular structure; friable consistency; occasionally somewhat cemented; pH — 6.7.

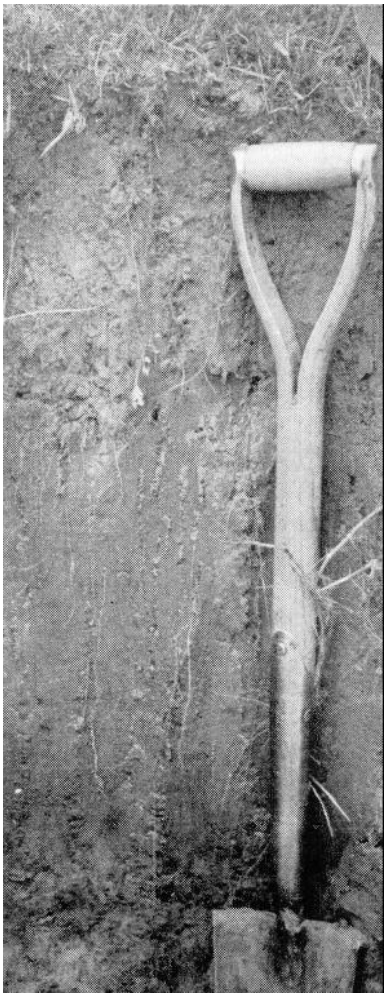
C — Grey (10YR6/1) sandy loam; single grain structure; stonefree; pH — 7.0.

D — Grey calcareous clay occurs at depths of three feet and less. pH — 7.4.

Occasionally on the better drained sites the Manotick exhibits characteristics similar to the Grey-Brown Podzolic soils, when a textural and colour horizon occurs at the juncture of the light and heavy textured materials.

As the sandy overburden approaches depths of three feet and greater a podzol profile may occur. In Grenville County this condition was not commonly found.

For the most part the internal drainage is good. Occasionally on the slightly undulating topography the heavy textured lacustrine layer obstructs the internal drainage, causing a mottled condition at the juncture of the two materials. If the underlying clay materials have sufficient slope, lateral drainage over the heavy textured layer is facilitated. In such a variable complex, wide variation is to be expected in the texture of the cultivated soil.



The Manotick sandy loam is underlain by clay at depths of three feet and less. The profile exhibits the characteristics of Brown Podzolic soils.

It ranges from a sand to areas where the clay comes to the surface and becomes incorporated with the lighter materials. The organic matter content is medium and the nutrient levels are similar to those of the Uplands sandy loam. If the roots reach and utilize the nutrients contained in the heavier textured layers the fertility levels are considerably improved over the sandy outwash types.

Agriculture

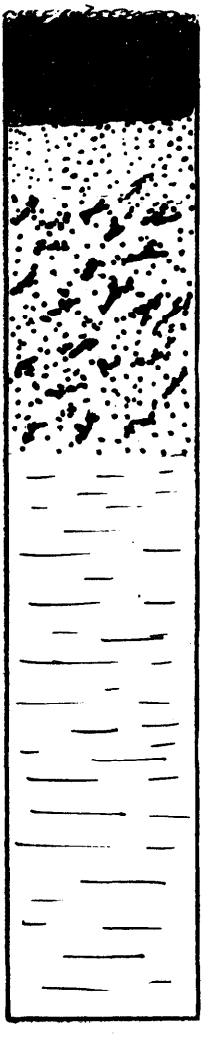
The Manotick sandy loam is generally used for dairy farming. Fertility and organic matter maintenance are the main requisites for successful farm

endeavours. Occasionally drainage problems are aggravated if the underlying clay comes close to the surface. The type is fairly well suited to the production of cereal grains, hay and pasture. Potatoes are grown with fair success and some orchards have been established on this type with very limited success. The acidity of the sandy deposits is occasionally low enough to warrant the application of ground limestone. Because of low lime content and low fertility the type is not well suited to the production of legumes. With the exception of the extremely light and extremely heavy textured portions of the Manotick sandy loam, a satisfactory nutrient and structural condition can be maintained by soil management practices commonly associated with successful dairy farming operations.

(b) Poor Drainage

Allendale sandy loam (13,300 acres)

The Allendale sandy loam occupies a larger area in Grenville County than its well drained associate, the Manotick sandy loam. It occurs in level to depressional areas and is poorly drained. The lime content of the sandy deposits is variable, the reaction ranging from slightly acid to neutral. The type developed under a tree growth consisting largely of white and black spruce, cedar and tamarack. The variability in depth of sand deposit makes it difficult to describe a commonly occurring profile. The following is a description of a virgin profile located in Oxford Township:



A_0 — Thin mat of leaf litter.

A_1 — 6″ very dark brown (10YR2/2) sandy loam; fine granular structure; very friable consistency; stonefree; pH — 6.4.

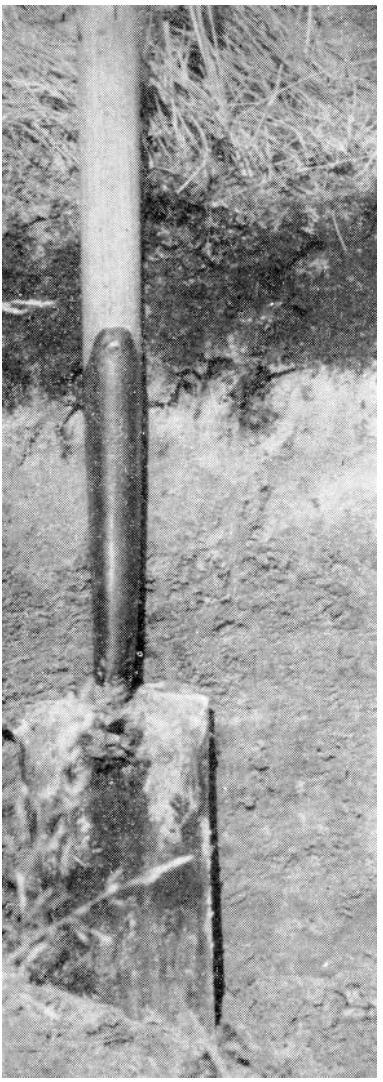
G_1 — 4″ grey (10YR6/1) sandy loam; single grain structure; slightly mottled; very friable consistency; stonefree; pH — 6.8.

G_2 — 15 inches grey (10YR6/1) sandy loam; intensely mottled; stonefree; slightly compacted above the clay layer; mottlings increase in intensity with increase in depth; pH — 7.0.

D — Grey plastic heavy clay; stonefree; massive structure; pH — 7.4.

The clay layer appears at depths of three feet and less and occasionally comes to the surface. In depressional areas the surface soil reaches a depth of 10 inches or more and approaches a muck condition. The type is well

supplied with organic matter but the fertility level is. Occurring on level to depressional topography it has not suffered from erosion.



The Allendale sandy loam is poorly drained. Note the dark surface and grey mottled sand underlain by clay. The clay occurs at depths of three feet and less.

Agriculture

This series is used largely for permanent pasture and woodland. It is not well suited to the production of most farm crops and the poor drainage condition lessens its usefulness as pasture land because of the low quality grasses it supports. It is a late soil in the spring and often buckwheat is the only grain crop planted. Areas that have been retired to permanent pasture are being invaded by willows and scrub tree growth. Drainage improvement is generally difficult because of the difficulty in obtaining outlets and the presence of the clay layer. Possibly the most effective type of drain would be deep

open ditches. The chief limitation of the type for the production of farm crops is poor natural drainage.

Allendale sandy loam, shallow phase (800 acres)

If limestone bedrock occurs at depths of three feet or less the Allendale sandy loam is mapped as a shallow phase. The occurrence of the bedrock further lessens the usefulness of the soil for agricultural purposes. The problem of improving drainage is greater and the shallow soils are more susceptible to seasonal variations. The shallow phase of the Allendale sandy loam is used for pasture land or tree growth.

F. SHALLOW SOILS OVER BEDROCK

(a) *Good Drainage*

Slightly more than 15 per cent of the Grenville County area has less than one foot of soil mantle overlying Beckmantown limestone bedrock. Differing from the limestone plains mapped in several other areas in Ontario, the underlying rock is quite massive. Large areas of shallow soils occur in Wolford, the western side of Oxford and in Augusta Townships. These limestone bedrock plains are occasionally broken by a low limestone till ridge or by level swamp land, but for the most part they appear as level to slightly undulating plains. When the weathered soil materials are of greater depths than one foot, the area was separated out as a shallow phase of the series or type which it resembles most closely.

Farmington soils (46,600 acres)

The Farmington supports a tree cover of white cedar, juniper and some red cedar. Maple appears in deeper crevices and areas where the materials reach more than a foot in depth. However, much of the maple has been cut off and white cedar remains as the dominant tree cover at the present time. The depth of soil over the underlying bedrock is so shallow that it is difficult to describe the type of profile that occurs on it. There is little differentiation in colour or texture within the weathered portion of the profile. The surface soil is usually a loam and a dark brown colour dominates the entire profile to the bedrock. Free carbonates are commonly found in the surface soil. The shallow soils are probably more closely related to the Brown Forest soils than to any other Great Soil Group.

Forestry and grazing are the chief endeavours found on the Farmington. Provided a farmer has sufficient acreage, fairly effective grazing can be obtained on the shallow soils for at least part of the season. Naturally they are very susceptible to droughts. During the spring season and again after the early fall rains they provide fair pasture. However, during the summer months they dry out badly and the carrying capacity for livestock is considerably reduced.

Crop production is practically prohibited by the droughty condition and the shallowness of the soils. Fertility improvement through soil management and nutrient building practices used on other types would not be economically feasible on the Farmington. The Farmington is submarginal cropland.

A large proportion of the Farmington is used for pasture land. This picture shows an area where the topsoil has been eroded away.

The value of the woodlots has been greatly reduced through the removal of the hard maple. Where the maple and cedar association has been left, fail incomes are derived from the sale of maple syrup and firewood.

The Farmington type of Grenville County is representative of a large land area in Eastern Ontario. In developing a land use program based on the use capabilities of these soils several factors merit attention. The early settlers occupied these lands possibly because they were well drained and supported good stands of cedar and maple. Once cleared it became apparent the size of farm unit on the shallow soils should have been considerably larger than on the more fertile deeper soils of the County. Hence, there has been a tendency for a few owners to acquire a number of farms on the Farmington soils and develop a system of farming that would provide a satisfactory farm income.

How effective reforestation will be remains to be seen. Through attempted agricultural endeavours and cultivation the organic matter content has been lowered. The re-establishment of maple trees will be difficult. Locally it is considered that the white cedar is not well adapted to the shallow soils because of the high incidence of hollow trees found on the Farmington. It has occurred to the writers that a representative block of this land closed from animals, and left to let Nature establish a vegetative cover, would provide valuable information relative to the use of these soils.

Forage crop improvement will be difficult because of the physical limitations, which very much lessen the effectiveness of soil amendments. Improved land use on the shallow soils of necessity will have to be based on a minimum

of capital expenditure because of the low market value of the land. Occasionally depressional or saucer-shaped areas occur within the Farmington and these were separated out as a depressional phase. The use and characteristics of these areas are similar to those of the Farmington. In Grenville County 1,400 acres of Farmington, depressional phase, occur.

G. ORGANIC SOILS

Slightly less than 15 per cent of the Grenville County area is occupied by organic soils. Fairly extensive bogs occur in all the townships, the largest ones being in Edwardsburg and Wolford. The organic soils are often referred to in literature as bog soils. The organic soils are developed on the accumulation of organic materials. The difference between Muck and Peat is one of stage of decomposition, the former being much more decomposed than the latter.

Muck (24,600 acres)

Muck soils are very dark in colour and have decomposed to a greater extent than Peat. The profile of a muck soil usually does not exhibit the characteristic layering commonly found on a mineral soil. The following description of a muck soil indicates the arrangement of the layers:

(1) Surface: Very dark grey or black (10YR2/1); well decomposed organic materials derived from sedges, leaves and other readily decomposable material. Variable depth. Neutral in reaction.

(2) The second layer contains more woody material and is less well decomposed.

(3) Sticky, dark in colour and well decomposed.

(4) Clay, till, sand or bedrock.

Muck usually occurs on depressional topography. The drainage is very poor and often muck land is under water for part of the season. The vegetative cover consists of elm, ash, white cedar and sedges, the latter being the dominant herbaceous plant. The reaction ranges from neutral to slightly alkaline. Often the seepage waters from the adjoining area contain large amounts of calcium which influences the reaction of the muck soils.

Use

There has been very little development of the muck soils in the County. In the Prescott area some of the muck soils are being used for market gardening purposes. To further develop the organic soils of Grenville County it is first necessary to improve the drainage which is costly and difficult. If the organic soils are used for market garden purposes they should serve a much more useful purpose if irrigated. However, the muck soils occur in areas where it is difficult to procure a source of water for irrigation purposes. For the most part the muck supports tree growth. If it occurs in close association with soils that are being used for the production of agricultural crops it is cultivated and included as part of the rotation land. Where the muck occurs close

to soils that are low in organic matter content it could be used as a source of organic material, particularly on the low fertility sands.

Peat (16,300 acres)

Extensive areas of Peat occur in Wolford and Augusta Townships. The peat has developed from mosses, reeds, cattails, scrub spruce, and tamarack. The vegetation in the centre of the bogs usually consists of leatherleaf, Labrador tea, huckleberry, and sphagnum moss. Tree growth is more scanty and scrubby than on the muck soils and usually consists of black spruce, white birch, and larch. It usually contains large quantities of only partially decomposed materials, is woody in nature, and brownish in colour. The drainage is very poor. Peat bogs usually occur on depressional topography.

Use

There has been practically no development on the peat deposits of Grenville County. Other than acting as reserves for water and to supply shelter and feed for wild life they are little used. The tree cover is of little value and a considerable portion of that already established has died. The depth of peat is variable, ranging from three to more than ten feet. Some of the peat bogs possibly could be developed for the production of blueberries and cranberries.

H. MISCELLANEOUS SOILS

Bottom land (4,500 acres)

The low lying soils along the stream courses, which are subject to flooding, are mapped as Bottom Land. About 4,500 acres of Bottom Land were mapped in Grenville County, occurring mainly along the South Nation River, Kemptville Creek and tributaries flowing into the St. Lawrence and Rideau Rivers.

The distinguishing characteristics of the profile are a dark coloured surface and a greyish water-soaked subsoil. The Bottom Land is an immature soil and shows little horizon differentiation. It is an *Alluvial* soil. The drainage is usually poor and varies somewhat with the height of water in the streams. Vegetation consists of willow, elm, cedar and alder. Where the Bottom Land is flooded for a large part of the season, bulrushes, sedges, and marsh grasses are common. Practically none of the Bottom Land is cultivated but is used largely as pasture land.

Rock (100 acres)

Only two of the small areas of rock outcrop that occur within the County are shown on the map. One is located north of Oxford Station and one along the boundary between Oxford and South Gower Townships, west of Millar's Corners. Numerous small outcroppings of limestone are included with the Farmington soils. The acreage of these outcroppings is so small that it is not felt they warrant further discussion other than to mention the significance of their appearance geologically.

PART IV

AGRICULTURE AND LAND USE

Early Settlement and Agricultural Development

The facilities afforded by the St. Lawrence and Rideau Rivers contributed to the early settlement of Grenville County. Situated opposite New York State on the St. Lawrence River it was a natural place for the United Empire Loyalists to settle when they fled from the newly born United States. The County was first entered in 1775 according to the Report of the Agricultural Commission of 1881, and the process of settlement was completed fifty-three years afterwards.

As in other parts of Ontario, lumbering was the first industry of the County. As the settlers cleared a small area of land they developed a self-sufficient type of agriculture to provide food for themselves and their live-stock. Of necessity a combination of lumbering and agriculture was common in the early days, with farmers concentrating their efforts on the production of agricultural commodities in the summer months and turning to lumbering endeavours in the fall and winter.

The agricultural development of Grenville County closely parallels the evolution and growth of the dairy industry in Eastern Ontario. From the earliest days dairying was the most important agricultural pursuit. The lumber camps provided a ready market for all agricultural produce, especially dairy products. Adequate marketing facilities were provided at Brockville, Prescott and Kemptville. The St. Lawrence River, Rideau Canal, Grand Trunk Railway, and the Canadian Central Railway afforded transportation conveniences, permitting farmers to take advantage of larger and more distant markets. The Report of the Agricultural Commission of 1881 indicates that there were 22 cheese factories and one creamery in the County at that time.

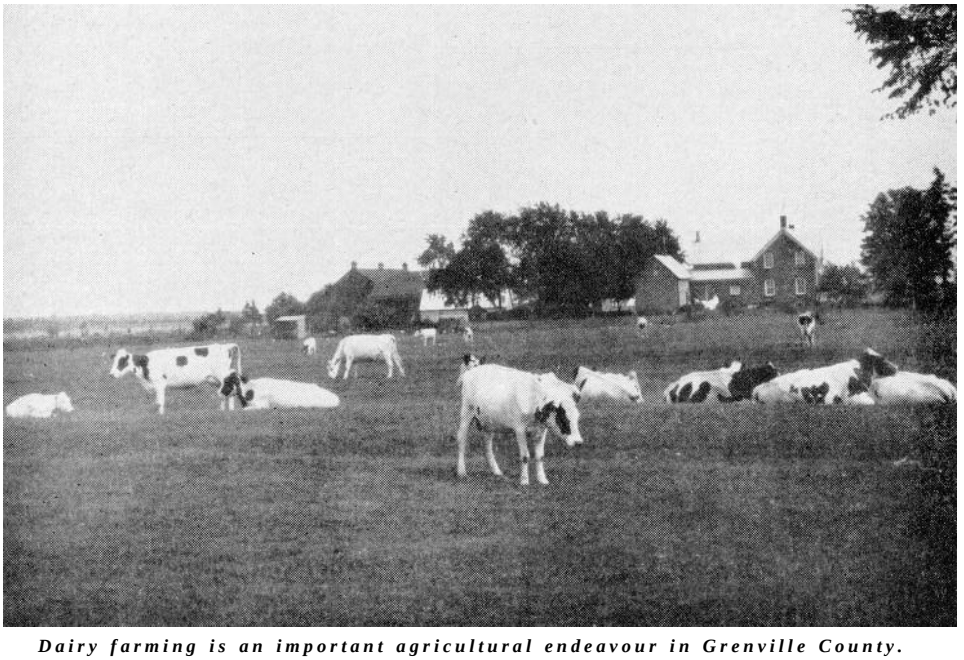
Local industries, in addition to those directly associated with dairying, included a starch factory, distillery, sawmills and flour mills.

Very little drainage improvement was practised in the early days and tile drainage was unknown. The importance of fertility maintenance was recognized soon after clearing operations had commenced and cognizance taken of the lack of plant nutrients. Superphosphate, plaster and salt were used to a limited extent on cereal grains and grasses as fertilizer supplements.

To trace the growth and development of agriculture in Grenville County would be to unravel a tale of progress and achievement. Attendant to the early settlement of the area was the development of the dairy industry with particular attention attached to the Holstein-Friesian breed. To those early settlers who had the foresight to appreciate the importance of dairy herds and the courage to procure good foundation stock, the County of Grenville is deeply indebted. Indeed, the export of Holstein-Friesian cattle to the United States is a sizeable and important phase of the dairy industry at the present time.

Present Agriculture

A large portion of the milk now produced in the area is processed at cheese factories located at Roebuck, Oxford Mills, Oxford Station, Patterson's Corners, Bishop's Mills, Heckston, Millar's Corners, Domville, Spencerville and elsewhere. The Towns of Kemptville and Prescott both maintain creameries for the manufacture of butter. Other important outlets for milk are the Montreal whole milk trade, the Chateau Cheese Company at Maitland, and Borden's Dairy at Easton Corners.



Dairy farming is an important agricultural endeavour in Grenville County.

Poultry raising is an important agricultural endeavour in the County and like many other areas in Ontario production has increased greatly in the last thirty years. Adjoining the St. Lawrence, Rideau, and Kemptville Rivers a few orchards are situated on the medium and light texture well drained soils. The Ottawa and Montreal markets provide a ready market for fruits. There are few specialized crops grown in the County, potatoes being the most commonly occurring cash crop.

Photograph by W. B. George, Kemptville

Some fine apple orchards are found along the St. Lawrence River in Grenville County.

The leadership and guidance offered by the extension services of both the Provincial and Dominion Departments of Agriculture have contributed to the agricultural development of the area. The Kemptville Agricultural School, The Agricultural Representative's Branch, and the Dominion Experimental Farm, Ottawa, have all provided assistance and factual information for the improvement of agriculture.

The following table from the 1941 Census of Canada indicates the present status of land use in Grenville County:

TABLE 8

PRESENT LAND USE (1941 CENSUS)

	Acres	Per Cent of Total
Total land area	296,320	
Area occupied land	257,171	86.8%
Area improved land	145,408	56.4%
Area unimproved land	111,763	43.6%

Over 86 per cent of the land area of Grenville County is occupied land. The remainder is made up of road allowances, large swamps and bogs, etc. According to the above figures slightly over 56 per cent of the occupied land is improved. A further breakdown of these figures reveals that the improved land consists of:

TABLE 9

PRESENT USE OF IMPROVED LAND

	Acres
Area of improved land	145,408
Field crops	97,972
Market garden	134
Orchard	460
Small fruits	42
Fallow	504
Pasture	41,340
Other	4,956

Field crops and improved pasture occupy slightly over 95 per cent of the improved land, and of this portion there is more than twice as much land in field crops as pasture. Only a small acreage is used for orchard purposes and this is found chiefly along the St. Lawrence and Rideau Rivers or in the immediate vicinity of the Kemptville Agricultural School.

The following figures are taken from the Annual Report of the Statistics Branch (1945), Ontario Department of Agriculture. The total acreage of field crops (101,622) differs slightly from that of the 1941 census (97,972), but this is understandable since the records apply to different years and the statistics were gathered by two agencies using different techniques for assembling data. A glance at the following table reveals the predominance of hay and clover, oats, ensilage corn, and alfalfa in the acreage of field crops of Grenville County. The acreage of high value cash crops is small, which is largely a reflection of unsuitable climatic environment. This is in direct contrast to some other sections of the Province where canning crops, tobacco and sugar beets occupy a large proportion of the cultivated land and furnish a sizable part of the farm income. The proportion of field crops grown presents a picture of the dominant type of agriculture in the area as well as reflecting some of the important soil features that influence the distribution of crops. Large acreages of ensilage corn, hay and clover, legumes, and mixed grain contribute to establishing successful dairy farms. Grenville County has a fairly large acreage of buckwheat, a reflection of the large proportion of inadequately drained soils.

TABLE 10

ACREAGE OF FIELD CROPS IN GRENVILLE COUNTY

(Annual Report of Statistics Branch, 1945, Ontario Department of Agriculture)

Hay and clover	49,914	
Alfalfa	7,019	
Sweet clover	1,825	
Alsike	415	59,173
Oats	15,440	
Mixed grain	5,862	
Buckwheat	4,792	
Barley	1,259	
Wheat	197	
Rye	92	27,642
Ensilage corn	12,830	
Potatoes	1,247	
Beans	374	
Soybeans	155	
Turnips	77	
Peas	22	
Flax	20	
Other field crops	82	14,807
TOTAL FIELD CROPS		101,622
Cleared pasture		49,290

The unimproved land of the County comprises slightly over 43 per cent of the occupied land. Table 11 from the 1941 Census shows the proportion of unimproved land in pasture, woodland and marsh.

TABLE 11

PRESENT USE OF UNIMPROVED LAND

	ACRES
Natural pasture	60,568
Woodland	36,007
Marsh	15,188
TOTAL	111,763

Over half the unimproved land is in natural pasture. Slightly more than 15 per cent (48,000 acres) of the Grenville County area has less than one foot of soil over the underlying bedrock. For the most part these shallow limestone plains are in natural pasture or woodland. In addition to the shallow soils large expanses of poorly drained depressional soils, such as the bottom land adjoining stream courses, remain in pasture land. Only a very small proportion of the muck has been developed for the production of cultivated crops, the remainder being left in woodland.

Slightly over 16,000 acres of Peat were mapped in Grenville County. Much of the peat supports a very sparse tree cover, the vegetation consisting largely of low growing shrubs, moss and leather leaf while on the fringes of the bogs white birch, spruce, elm, and alder take over.

The following table taken from the 1941 Census gives a generalized picture of the types of farms in Grenville County:

TABLE 12

TYPE OF FARM IN GRENVILLE COUNTY (1940)

Total number of farms	1,914
Grains and hay	45
Potatoes, roots and other field crops	8
Vegetables, fruits and nursery crops	29
Dairy products	457
Poultry	23
Livestock	111
Forest and apiary products	10
Subsistence and combination of subsistence	406
Mixed farming	816
Part-time	56

The above classification is based on the source or sources of farm revenue. Mixed farms are farms where the revenue from two or more of the other main types of products were required to produce 50 per cent or more of the gross revenue. Subsistence farms are those on which the value of products consumed or used by the farm household amounted to 50 per cent or more of the gross revenue. Combination of subsistence farms are farms where the value of products used or consumed and the revenue from another main type such as poultry, livestock, etc., were required to form 50 per cent or more of the gross farm revenue.

Utilization and Management of Grenville County Soils

Thus far in this report attention has been directed to those factors that have influenced the development of Grenville County soils. The effect of the soil forming processes is reflected in the soil profile, which exhibits characteristics that are used as criteria for classifying and mapping different soil types. In the processes of soil formation environmental factors have taken dominance over the influence of man. However, once soils are used for the production of agricultural crops we are confronted with a study of the relationships among soils, crops, and men.

For profitable and continued agricultural enterprises a harmonious balance must exist among these factors. Many of the relationships between soil conditions and plant growth require detailed studies which are beyond the scope of the soil survey. However, the examination and mapping of soils does afford an opportunity to study the effect of chemical and physical features on the distribution and growth response of crops commonly grown in the area. Those observations made during the field work are presented herewith.

For purposes of this discussion the soils of Grenville County have been grouped on a "textural" basis. In so far as possible the sands and sandy loams have been placed in the "light textured" group, the loams and silt loams in the "medium textured" group, and the clays and clay loams with the "heavy textured" soils. The shallow soils, with dominantly one foot and less of soil material over bedrock are discussed under shallow soils over bedrock and the peat and muck under organic soils.

Group 1—Light Textured Soils

TABLE 13

ACREAGE OF LIGHT TEXTURED SOILS

Soil Type	Acreage	Total
(a) Well drained		
Kars gravelly sandy loam	3,800	
Grenville sandy loam	8,300	
Grenville sandy loam, shallow phase	1,900	
Uplands sand	15,800	
Uplands sandy loam	2,200	32,000
(b) Imperfectly drained		
Manotick sandy loam	8,300	
Rubicon sand	29,600	
Rubicon sand, shallow phase	400	
Rubicon sandy loam	5,400	43,700
(c) Poorly drained		
Allendale sandy loam	13,300	
Allendale sandy loam, shallow phase	800	
Granby sand	9,600	
Granby sandy loam	24,000	47,700
		123,400

Over 123,000 acres of light texture soils have been mapped in this County. As pointed out in the series descriptions (Part III), the components of this group vary in drainage, underlying material, and stoniness.

The well drained components (Uplands, Kars and Grenville sandy loam) have low moisture retaining qualities. In a normal season they tend to be droughty and respond readily to frequent showers. Because of their coarse, porous nature the soluble salts are readily leached. The utilization of the soils contained in this group is strongly influenced by moisture relationships and fertility levels.

Inherently they are low in plant nutrients and the Uplands in particular has a low organic matter content. Under cultivation the Uplands sand has suffered fairly extensively from wind erosion.

The Kars and Grenville sandy loam differ from the Uplands soil in that the surface is stony, and they are not as excessively drained as the latter. They are better suited to the production of most farm crops, provided satisfactory fertility and organic matter levels are maintained. The level to undulating areas of Uplands respond to heavy applications of fertilizer and barnyard manure and produce fair crops. The Uplands series is fairly well suited to row crops such as potatoes. The well drained light textured soils are suitable for tree fruits as evidenced by the orchard at the Central Experimental Farm, Ottawa. The rolling areas that are susceptible to and in many cases have already suffered from wind erosion might well be returned to tree cover to stop or prevent this menace.

The imperfectly drained, light textured soils include the Manotick and Rubicon series. The Manotick is much the better soil since its topographic and drainage conditions are less variable than the Rubicon. Organic matter and fertility maintenance are the main requirements contributing to successful land use on the Manotick series. Clay usually occurs at depths of three feet

and less. The presence of the heavy textured layer appears to be an asset for the production of most farm crops. The Manotick has the advantage of being a fairly early soil in the spring and possesses characteristics that permit the growing of a fairly wide range of crops. It is rated among the better agricultural soils of Grenville County. The Rubicon, because of the variability in topographic and drainage conditions, presents many problems in soil management. The imperfectly drained basins are in direct contrast to the well drained knolls. In the Rubicon excessive and poor drainages often occur in association with one another within relatively small areas which complicates soil management. This variation in drainage conditions is one of the main hazards to the production of farm crops. Wind erosion has affected part of the Rubicon series. In the northern part of the County the Rubicon has generally a more acid reaction than in the southern part and should respond to applications of limestone.

The lowering of the water table in the poorly drained light textured soils (Granby and Allendale) is the main requirement for improved land use. However, once drainage improvement is effected, organic matter and plant nutrient levels are rapidly lowered. Unless proper management practices are followed, care must be exercised in altering the drainage on these types so as not to create an excessively drained condition. The Allendale is underlain by heavy textured materials (clay and clay loam) at depths of three feet and less. This type often occurs as level to depressional plains, making drainage improvement difficult.

The Granby and Allendale grow about the same crops. They are late soils in the spring and often fairly large acreages are used for growing buckwheat. A large proportion of the poorly drained, light textured soils remains in pasture or forest land. This is particularly true of areas adjoining stream courses. The high water table inhibits the growth of deep rooted legumes and grasses that are necessary for good forage. Alsike grows fairly well but the high water table practically prohibits the inclusion of red clover and alfalfa in the hay mixtures. Only fair crops of hay, usually made up of timothy and alsike, are produced. Because of the rather scanty forage crop production combined with poor management, willows and scrub growth are beginning to encroach upon these soils making them less useful for pasture land.

In summary, the light textured soils of Grenville County suffer from one or more of the following factors: low fertility levels, poor drainage and wind erosion. Low fertility and wind erosion limit successful crop production on the well drained areas. Provided these hazards are corrected, general farm crops, row and fruit crops are grown with fair success. Drainage improvement is necessary to increase the usefulness of the poorly drained areas and with improved drainage the imperfectly and poorly drained soils will be capable of growing a wider range of crops than they do under present conditions.

Group 2—Medium Textured Soils

TABLE 14

ACREAGE OF MEDIUM TEXTURED SOILS

Soil Type	Acreage	Total
(a) Well drained		
Grenville loam	29,700	
Grenville loam, bouldery phase	1,900	
Grenville loam, shallow phase	8,700	40,300
(b) Imperfectly drained		
Matilda loam	9,000	
Matilda loam, bouldery phase	200	
Matilda loam, shallow phase	3,000	12,200
(c) Poorly drained		
Lyons loam	4,000	
Lyons loam, shallow phase	1,300	
Osgoode loam	3,900	
Osgoode silt loam	4,100	13,300
		65,800

The medium textured group contains the fine sandy loams, loams, and silt loams and occupies about 65,000 acres of the soils of Grenville County. These can be further subdivided on the basis of drainage and stoniness.

The use and management of the Grenville loam was discussed in Part III (page 31). With satisfactory rotations and good soil management it produces good yields of most farm crops. Occurring on rolling till plains it is susceptible to sheet erosion but this hazard can be adequately controlled through the use of relatively simple erosion control measures. This soil responds to applications of potassic and phosphatic fertilizers. Soil management practices that will provide more organic matter and maintain fertility levels are desirable. The use of the bouldery phase of the Grenville is limited by excessive quantities of stones that inhibit its use as rotation land. This phase appears to serve a very useful purpose as pasture land. Areas where bedrock occurs at depths of three feet and less and which exhibit characteristics similar to the Grenville were separated as a shallow phase. Such areas are more droughty than the normal Grenville and in dry seasons suffer from unsatisfactory plant-moisture relationships and consequently are not reliable soils.

The Matilda series is the imperfectly drained associate of the Grenville soils. The imperfect drainage narrows the range of crops that can be grown. Except for the drainage condition it is comparable to the Grenville. It is somewhat better supplied with organic matter but is not as well suited to the production of alfalfa due to unsatisfactory drainage.

The Lyons loam is a poorly drained stony soil. The surface soil often approaches a mucky condition. The Lyons loam usually occurs in depressional or trough-like topographic positions in association with the Grenville and Matilda soils. Poor drainage and stoniness limit its usefulness for crop production with the result that the greater portion of it is left for pasture and woodland. It is seldom economically feasible to improve the drainage since the inherent lack of fertility and good physical structure does not warrant such expenditure.

The poorly drained, stonefree Osgoode loam and silt loam usually occur close to present or former stream courses and are not found in as large expanses as in Carleton County. The poor drainage, particularly in wet seasons, limits the usefulness of these oils. In an average season they produce good crops of grains and hay. A fairly large proportion is used for pasture land. They are well supplied with organic matter, and respond to applications of mineral fertilizers. Satisfactory physical conditions can be maintained through use of good soil management practices. Improved drainage would greatly increase the usefulness of the Osgoode series, since inherently it is fairly well supplied with plant nutrients.

Group 3—Heavy Textured Soils

TABLE 15

ACREAGE OF HEAVY TEXTURED SOILS

Soil Type	Acreage	Total
(a) Well drained		
Wolford clay loam		1,400
(b) Imperfectly drained		
Carp clay loam		2,400
(c) Poorly drained		
North Gower clay loam	6,400	
North Gower clay loam, shallow phase	1,300	7,700
		11,500

Components of this group include the well drained stony Wolford series and the imperfectly drained Carp and poorly drained North Gower series.

The Wolford soils occur in the Easton Corners area and with the exception of heavier texture possess characteristics similar to the Grenville loam. It grows a wide range of crops and appears to be especially well suited to the production of cereal grains, hay, including alfalfa, and ensilage corn.

The stonefree heavy soils of Grenville County do not occur in broad plains but are found in small scattered patches mainly along the rivers. Slightly over 8,500 acres were mapped in the County. In the North Gower series the clay content is high which inhibits the internal movement of the soil water, frequently resulting in a water-logged condition. The North Gower clay loam has a tendency to be plastic and sticky when wet and to bake and shrink when dry. The level of plant nutrients is usually fairly high and the organic matter content is good.

Improved internal and external drainage would greatly increase the utility of these heavy textured soils. This could be effected through tile drainage or by open ditches. The usefulness of these clay and clay loam soils is strongly influenced by seasonal differences. In excessively wet seasons the soils become water-logged making it practically impossible to cultivate the land. During normal seasons they are well suited to the production of grain crops, hay and pasture. Poor drainage practically prohibits the growing of alfalfa. The Carp series possesses better internal and external drainage than the North Gower series. It is a more reliable soil and does not suffer as extensively in late wet

seasons. The Carp clay loam is well supplied with plant nutrients and produces good yields of crops commonly grown in the area. It is rated among the better agricultural soils of Grenville County.

These heavy textured soils often occur in association with limestone till ridges. This makes a still more desirable combination, the rolling till soils providing some early land and building sites. When such a condition occurs it is possible to develop a system of soil management whereby the heavy textured areas can be used for the production of cereal grains and pasture and the better drained till soils used for crops demanding better aeration, etc.

Group 4—Acreage of Shallow Soils Underlain by Bedrock

TABLE 16

SHALLOW SOILS UNDERLAIN BY BEDROCK

	Acreage	Total
Farmington	46,600	
Farmington imperfectly drained	1,400	48,000

Slightly less than 50,000 acres of the soils of Grenville County have a mantle of soil less than one foot in depth. The Farmington soils make up this acreage. The characteristics and use of the Farmington has been discussed in Part III.

For the most part these soils are used for pasture or woodland, a use that appears to fit their capabilities very well. The majority of the shallow soils are found in the western half of the County although the occasional outcrop occurs in the eastern half as well. Seasonal variations noticeably affect the drainage conditions of the shallow soils. In seasons of high rainfall they are wet and imperfectly drained. In droughty periods they suffer greatly due to the shallowness of the soil mantle over bedrock.

Attempts to grow general farm crops on the shallow soils have been unsuccessful. Fair pastures are produced provided adequate and fairly frequent precipitation occurs. Good stands of white cedar, which find a ready market in the form of fence posts, may be found.

Because of the limitations placed on these soils through shallowness it would appear to be desirable that they be left as pasture or forest land.

Group 5—Organic Soils

TABLE 17

ACREAGE OF ORGANIC SOILS

	Acreage	Total
Muck	24,600	
Peat	16,300	40,900

The organic soils occupy over 40,000 acres in Grenville County. Only a very small proportion of the organic soils has been developed for agricultural purposes. For the most part they remain wooded and as such they appear to be serving their most useful purpose.

Adaptability Rating for Grenville County Soils

Oats, barley, alfalfa, red clover, alsike, timothy, fodder corn, potatoes, permanent pasture, and tree fruits are crops that are commonly grown in Grenville County. The soils of Grenville County differ considerably in their adaptability to produce the various crops commonly grown in the area. Some soils are capable of producing high yields of one or more crops but poorly suited to other crops. Some soils have an inherently high productive capacity while others have an inherently low productivity.

The suitability of a soil to produce a crop is influenced by both its chemical and physical features. An attempt is made to evaluate those characteristics that create a satisfactory environment for the crops being considered. Such an environment is affected by both external and internal features of the soil. Suitability of soils to produce crops will vary according to differences in organic matter content, texture, structure, reserve of plant nutrients and their availability, need for erosion control and removal of stones, depth to bedrock, etc.

Several methods have been used for making ratings. The most absolute and definite rating would be to collect yields of crops according to soil type. Such a system would necessitate interviewing a large number of farm operators. Unfortunately few farmers have accurate crop yield records so that data collected in this manner will only be as good as the memory of the person interviewed. Relatively few men can remember yields from individual fields for more than a year without the aid of records. If a system were evolved whereby one could manipulate the various phenomena that influence production and measure the effect exercised, then a rating could be made on a fairly scientific basis. It is difficult to design a means whereby such an evaluation could be reached.

The fertile clay plains of Eastern Ontario are well suited to the production of cereal grains, hay and pasture, provided the climatic environment is satisfactory. Large areas of poorly drained (over 95,000 acres) and of imperfectly drained (about 70,000 acres) soils occur in Grenville County. In wet seasons spring cultivation is delayed and occasionally unfavourable weather conditions prohibit the planting of cereal crops. Thus the adaptability of these soils for producing crops is much lessened. Indeed, when such conditions prevail, the less fertile well drained sands have a greater use capability than the poorly and imperfectly drained clay plains. A different condition prevails in areas where shallow soils over bedrock predominate. The shallow soils have low moisture holding capacity and suffer in extended dry periods. This need for a continuous supply of moisture through frequent and well distributed rainfall merits attention in developing a rating for shallow soils.

It is difficult to define a wet and a normal season. Frequency, intensity and amount of rainfall all affect the picture. The fact is, a wet season greatly alters and influences the adaptability of Grenville County soils to produce crops. Accordingly the soils have been rated for average and a wet season in an attempt to indicate the effect of seasonal differences on the use capability of soil types.

No system of rating should be looked upon as carrying an implication of mathematical precision. The ratings are made for crops commonly grown in

the area under prevailing systems of management. The productivity of any soil will vary with management. Management includes all those operations and materials that go into producing a crop. It includes all of the drainage, tillage, seed treatment, planting, fertilizing, spraying, harvesting and other operations that produce the crop, as well as crop varieties. Obviously an opportunity to measure the effect of these factors was not afforded the writers. The ratings are developed to indicate the capabilities of Grenville County soils to produce crops under average systems of management and environmental conditions. The ratings are made for crops commonly grown in the area. With the introduction of new varieties, new systems of soil management and other unforseen factors the ratings of necessity may be adjusted and changed. The rating for Grenville County soils is based on observations made during the progress of the survey, by data and opinions furnished by agronomic and soil workers familiar with the area and by consultation with local farmers and others.

TABLE 18

CROP ADAPTABILITY RATINGS FOR GOOD CROPLAND*

Soil Type	Oats		Barley		Alfalfa		Red Clover		Alsike		Timothy		Permanent Pasture		Fodder Corn		Tree Fruits		Potatoes	
	N†	W‡	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W
Wolford clay loam	G	G–F	G	G–F	G	G–F	G	G–F	G	G	G	G	G	G	G	G–F	F–P	F–P	F	F–P
Carp clay loam	G	G–F	G	G–F	G	G–F	G	G–F	G	G	G	G	G	G	G	F	F–P	F–P	F	F–P
Grenville loam	G–F	G–F	G–F	G–F	G–F	G–F	G–F	G–F	G–F	G–F	G–F	G–F	G	G	G	G–F	G–F	F	F	F
Osgoode loam	G	F	G	G–F	F	F–P	G–F	F	G	G	G	G	G	G	C–F	F–P	P	P	F	F–P
Osgoode silt loam	G	F	G	G–F	F	F–P	G–F	F	G	G	G	G	G	G–F	G–F	F	P	P	F	F–P
North Gower clay loam	G	F	G	F	F–P	P	G–F	F	G	G	G	G	G	G	F	F–P	P	P	F–P	P

*The crop adaptability rating for each soil type as follows: G — Good; G–F — Good to Fair; F — Fair; F–P — Fair to Poor; P — Poor.

†N — Normal Season. ‡W — Wet Season.

TABLE 19

ACREAGES OF GOOD CROPLAND

Soil Type	Acreage	Percentage of Total	Limitations
Wolford clay loam	1,400	0.48	Susceptibility to erosion
Carp clay loam	2,400	0.82	Imperfect drainage
Grenville loam	29,700	10.0	Susceptibility to erosion
Osgoode loam	8,000	2.7	Poor drainage
Osgoode silt loam	4,100	1.4	Poor drainage
North Gower clay loam	6,400	2.1	Poor drainage
Total	52,000	17.5%	

TABLE 20

CROP ADAPTABILITY RATINGS FOR GOOD TO FAIR CROPLAND*

Soil Type	Oats		Barley		Alfalfa		Red Clover		Alsike		Timothy		Permanent Pasture		Fodder Corn		Tree Fruits		Potatoes	
	N†	W‡	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W
Manotick sandy loam	G-	F	F	F	G-F	F	G-F	F	G-F	F	G-F	G-F	F	F	G-F	F	F-P	F-P	G-F	F
Matilda loam	G-	F	G-F	F	F	F-P	G-F	F	G-F	F	G-F	G-F	G	G-F	F	F-P	F-P	F-P	F	F-P
Grenville sandy loam	F	F	F	F	F	F	F	F	F-P	F	F	F	F	G-F	G-F	G-F	G-F	G-F	G-F	G-F
North Gower clay loam, shallow phase	F	F	F	F	F	F-P	F	F	G-F	G-F	G-F	G-F	G-F	G-F	F	F	P	P	F	F-P
Kars gravelly sandy loam	F	F	F	F	G-F	G	F-P	P	F-P	P	F-P	F	F-P	F	G-F	G-F	G-F	G-F	G-F	G-F

*The crop adaptability rating for each soil type is as follows: G — Good; G-F — Good to Fair; F — Fair; F-P — Fair to Poor; P — Poor.

†N — Normal Season. ‡W — Wet Season.

TABLE 21

ACREAGES OF GOOD TO FAIR CROPLAND

Soil Type	Acreage	Percentage of Total	Limitations
Manotick sandy loam	8,300	2.8	Low fertility, some imperfect drainage
Matilda loam	12,200	4.1	Imperfect drainage
Grenville sandy loam	10,200	3.5	Low fertility
North Gower clay loam, shallow phase	1,300	0.4	Shallowness to bedrock and poor drainage
Kars gravelly sandy loam	3,800	1.3	Low fertility
Total	35,800	12.1%	

TABLE 22

CROP ADAPTABILITY RATINGS FOR FAIR CROPLAND*

Soil Type	Oats		Barley		Alfalfa		Red Clover		Alsike		Timothy		Permanent Pasture		Fodder Corn		Tree Fruits		Potatoes	
	N†	W‡	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W
Grenville loam, shallow phase	F	F	F	F	F	F	F	F	F	F	G–F	G–F	G–F	G–F	F	F–P	P	P	F	F
Matilda loam, shallow phase	F	F	F	F	F–P	P	F	F	G–F	G–F	G–F	G–F	G–F	G–F	F	F–P	P	P	F–P	F–P
Uplands sandy loam	F–P	F	F–P	F	F–P	F	F–P	F	P	F–P	F–P	F–P	P	F–P	F	G–F	F	F	G–F	G–F
Rubicon sandy loam	F	F–P	F	F–P	P	P	F	F–P	F	F–P	F–P	P	F–P	F–P	F	F–P	F–P	F–P	F	F–P

*The crop adaptability rating for each soil type is as follows: G — Good; G–F — Good to Fair; F — Fair; F–P — Fair to Poor; P — Poor.

†N — Normal Season. ‡W — Wet Season.

TABLE 23

ACREAGES OF FAIR CROPLAND

Soil Type	Acreage	Percentage of Total	Limitations
Grenville loam, shallow phase	8,700	2.94	Shallowness to bedrock
Matilda loam, shallow phase	3,000	1.0	Shallowness to bedrock and imperfect drainage
Uplands sandy loam	2,200	0.76	Low fertility
Rubicon sandy loam	5,400	1.8	Low fertility and imperfect drainage
Total	19,300	6.5%	

TABLE 24

CROP ADAPTABILITY RATINGS FOR FAIR TO POOR CROPLAND*

Soil Type	Oats		Barley		Alfalfa		Red Clover		Alsike		Timothy		Permanent Pasture		Fodder Corn		Tree Fruits		Potatoes	
	N†	W‡	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W
Grenville sandy loam, shallow phase	F-P	F-P	P	F-P	P	F-P	P	F-P	F-P	F	F-P	F	F-P	F	F-P	F	P	P	F-P	P
Granby sandy loam	P	P	P	P	P	P	P	P	F	F	P	P	F-P	P	P	P	P	P	P	P
Allendale sandy loam	F-P	P	P	P	P	P	F-P	P	F	F	F	F	F	F-P	P	P	P	P	P	P
Lyons loam	F-P	P	F-P	P	P	P	P	P	F-P	F-P	F-P	F-P	G-F	F-P	P	P	P	P	P	P

*The crop adaptability rating for each soil type is as follows: G — Good; G-F — Good to Fair; F — Fair; F-P — Fair to Poor; P — Poor.

†N — Normal Season. ‡W — Wet Season.

TABLE 25

ACREAGES OF FAIR TO POOR CROPLAND

Soil Type	Acreage	Percentage of Total	Limitations
Grenville sandy loam, shallow phase	1,900	0.6	Shallowness to bedrock and low fertility
Granby sandy loam	24,000	8.2	Poor drainage
Allendale sandy loam	13,300	4.4	Poor drainage
Lyons loam	5,300	1.8	Poor drainage and stoniness
Total	44,500	15.0%	

TABLE 26

CROP ADAPTABILITY RATINGS FOR POOR CROPLAND*

Soil Type	Oats		Barley		Alfalfa		Red Clover		Alsike		Timothy		Permanent Pasture		Fodder Corn		Tree Fruits		Potatoes	
	N†	W‡	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W
Rubicon sand	P	P	P	P	P	P	P	P	F-P	P	F	F-P	F-P	F-P	P	F-P	P	P	P	P
Uplands sand	P	F-P	P	F-P	P	P	P	F-P	P	P	P	F-P	P	F-P	P	F-P	P	P	F-P	F
Lyons loam, shallow phase	P	P	P	P	P	P	P	P	P	P	P	P	F	F-P	P	P	P	P	P	P
Allendale sandy loam, shallow phase	P	P	P	P	P	P	P	P	F-P	P	P	P	F-P	P	P	P	P	P	P	P
Rubicon sand, shallow phase	P	P	P	P	P	P	P	P	F-P	P	P	P	P	P	P	P	P	P	P	P

*The crop adaptability rating for each soil type is as follows: G — Good; G-F — Good to Fair; F — Fair; F-P — Fair to Poor; P — Poor.

†N — Normal Season. ‡W — Wet Season.

TABLE 27

ACREAGES OF POOR CROPLAND

Soil Type	Acreage	Percentage of Total	Limitations
Rubicon sand	29,600	10.0	Imperfect drainage and low fertility
Uplands sand	15,800	5.3	Low fertility and susceptibility to wind erosion
Lyons loam, shallow phase	1,300	0.4	Shallowness to bedrock and poor drainage
Allendale sandy loam, shallow phase	800	0.2	Shallowness to bedrock, poor drainage, low fertility
Rubicon sand, shallow phase	400	0.1	Shallowness to bedrock, low fertility and imperfect drainage
Total	47,900	16.0%	

TABLE 28

ADAPTABILITY RATINGS FOR SUBMARGINAL CROPLAND*

Soil	Oats		Barley		Alfalfa		Red Clover		Alsike		Timothy		Permanent Pasture		Fodder Corn		Tree Fruits		Potatoes	
	N†	W‡	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W
Grenville loam, boulder phase	P	P	P	P	P	P	P	P	P	P	P	P	G	G	P	P	P	P	P	P
Matilda loam, boulder phase	P	P	P	P	P	P	P	P	P	P	P	P	G	G–F	P	P	P	P	P	P
Bottom Land	P	P	P	P	P	P	P	P	P	P	P	P	F	F	P	P	P	P	P	P
Farmington	P	P	P	P	P	P	P	P	P	P	P	P	F–P	P	P	P	P	P	P	P
Farmington, imperfectly drained	P	P	P	P	P	P	P	P	P	P	P	P	F–P	P	P	P	P	P	P	P
Muck	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Peat	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Rock	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P

*The crop adaptability rating for each soil is as follows: G — Good; G–F — Good to Fair; F — Fair; F–P — Fair to Poor; P — Poor.

†N — Normal Season. ‡W — Wet Season.

TABLE 29

ACREAGES OF SUBMARGINAL CROPLAND

Soil	Acreage	Percentage of Total	Limitations
Grenville loam, boulder phase	1,900	0.64	Excessive stoniness
Matilda loam, boulder phase	200	0.06	Excessive stoniness
Bottom Land	4,500	1.5	Susceptibility to periodic flooding
Farmington	46,600	15.6	Shallowness to bedrock
Farmington, imperfectly drained	1,400	0.47	Shallowness to bedrock and imperfect drainage
Muck	24,600	8.2	Very poor drainage
Peat	16,300	5.5	Very poor drainage
Rock	100	0.03	Rock outcrop
Total	95,600	32.0%	

PART V
DISCUSSION OF ANALYTICAL DATA

The results of the physical and chemical analyses are presented in Tables 30 and 31. The samples are of the surface soil and were taken from permanent pasture fields wherever possible to avoid variations due to management practices.

Mechanical Analysis

The Bouyoucos Hydrometer Method was employed to determine the texture of Grenville County soils. The amount of each size group of particles (soil separate) is reported on a percentage basis. Table 30.

Soil Classes and Percentage of Various Soil Separates in Each Class*

I. Soils containing less than 20 per cent clay.
   (a) Sand — soil with more than 80 per cent sand.

II. Soils containing less than 20 per cent clay and 50–80 per cent sand.
   (a) Sandy loam — soil with over 25 per cent fine gravel, coarse and medium sand.
   (b) Fine sandy loam — soil with over 50 per cent fine sand or under 25 per cent fine gravel, coarse and medium sand.

III. Soils containing less than 20 per cent clay, less than 50 per cent silt and less than 50 per cent sand.
   (a) Loam — soil with less than 20 per cent clay and less than 50 per cent silt.

IV. Soils containing over 50 per cent silt and less than 20 per cent clay.
   (a) Silt loam — soils with over 50 per cent silt and less than 50 per cent clay.

V. Soils containing more than 20 per cent clay.
   (a) Clay loam — soils with 20–30 per cent clay and less than 50 per cent silt.
   (b) Clay — soils with over 30 per cent clay.

A discussion of the soils in the above soil classes will be found in Part IV.

Reaction

The range of reaction of the soils of Grenville County is from pH — 5.4 to 7.8. However, the majority of the soils have a pH of 6.0 to 7.2. The light textured soils of the Uplands, Kars and Rubicon Series with a pH of 6.0 and less should respond well to the addition of lime for certain crops particularly legumes. The till soils (Grenville, Wolford, Matilda) are about neutral in reaction being developed close to the calcareous bedrock. The lacustrine clays also have a pH of about 7.0 indicating the presence of sufficient lime.

Phosphorus

The Lohse and Ruhnke method of determining readily soluble phosphorus was employed for Grenville County soils. The total phosphorus in the soils was not determined.

*Soil classes which are used throughout this report.

The above authors state that soils containing 60 pounds or less of readily soluble phosphorus per acre will show a very marked phosphate deficiency. About 28 per cent of the samples analyzed show a readily soluble phosphorus content of less than 60 pounds per acre. In general the light textured soils show a deficiency of phosphorus, while the medium to heavy textured soils are fairly well supplied. A deficiency as a result of phosphate fixation is often evident in soils which are high in lime. No figure has been suggested to indicate what may be considered a sufficient amount of phosphorus for general farm crops but 200 pounds per acre might be accepted as a tentative figure for soils of neutral reaction. There is a great need for correlation work between soil tests and fertilizer recommendations and crop response for the important soil types of the area. Some good work is being done but it should be intensified and extended.

It is of interest to note the general increase in phosphorus in the surface soils from Southwestern Ontario to Eastern Ontario. The heavy textured surface soils of Essex County have an average content of 80 pounds of soluble phosphorus per acre. In Carleton County the average is 260 pounds per acre. The sixteen samples of clay loams taken in Grenville County average 192 pounds of soluble phosphorus per acre.

The light textured soils in Grenville County (Uplands, Rubicon, Granby, Kars and Grenville) appear to have a deficiency of phosphorus. In some cases, the number of samples collected was insufficient to give accurate information regarding the chemical make-up of the soil type. Hence the results presented in Table 30 serve only as a general indication.

Potassium

Using the figure of 167 pounds of replaceable potassium per acre as being necessary for general farm crops, it will be noted that most of the soils in Grenville County have a deficiency of this important plant nutrient.

However, the heavy textured soils show amounts of potassium which are adequate. For specialized crops such as apples and potatoes extra potassium may be required. The light textured soils are low in potassium.

The amount of potassium available in a soil depends on several factors, one of the important ones being management practices. Freezing and thawing, wetting and drying have an effect on the amount of potassium which becomes available and the amount which is fixed in the soil. However, the results presented in Table 30 may be considered adequate for comparison between soil types.

Calcium and Magnesium

The elements calcium and magnesium both are derived chiefly from the carbonate forms in which they occur in the limestone bedrock. Conditions which effect the breakdown of the limestone affect the availability of these two elements. The exchangeable forms of calcium and magnesium represent the major portion of the available supply.

Truog states that in fertile loam soils that are not more than slightly acid there are 3,000 to 5,000 pounds of exchangeable calcium per acre plow layer and about one-fourth to one-third as much magnesium. On this basis, only

the light textured soils (Uplands, Rubicon, Kars and Manotick) are low in calcium, although there may be lime in the subsoil. Those soils developed on parent materials which contain many fragments of limestone are high in calcium and the stonefree clay loams are also fairly well supplied with calcium. If 1,000 pounds of magnesium per acre plow layer is taken as being the minimum required for general farm crops, the light textured soils show a deficiency again, many of them having less than 500 pounds per acre. On the other hand the medium to heavy textured soils are fairly well supplied with magnesium.

Organic Matter

The variations in organic matter content of surface soils are very great. In many instances the variations within a soil type are greater than between soil types. In general, however, the light textured soils contain less organic matter than the heavy textured soils, although the supply of organic matter in the soils of Grenville County is generally adequate. The importance of organic matter in determining the fertility, moisture holding capacity, structure, and productivity of a soil has been stressed throughout the report. The importance of organic matter in soils cannot be overemphasized.

Base Exchange Capacity and Per Cent Saturation

The base exchange capacity and per cent saturation of surface samples from Grenville County are presented in Table 31. In order to clarify the meaning of the data in the table, it is advisable to explain the meaning of the terms.

Base Exchange Capacity

It may be noted in Table 30 that soil is made up of particles of various diameters. Those particles of <.002 mm. are called clay and they are colloidal in size. A large part of the organic matter is also colloidal. All particles of colloidal size, either organic or inorganic, have the ability to hold basic (positively charged) ions (e.g. Ca^{++}, Mg^{++}, K^{+}, Na^{+}, H^{+}) on their surfaces. A positively charged ion held on the colloid may be replaced or exchanged by another positively charged ion from the soil solution. See Figure 9. Such a reaction is called "Base Exchange." The number of basic ions (cations) which a colloid can hold is expressed in millequivalents. The number of millequivalents of cations which 100 gms. of soil will adsorb is known as the Base Exchange Capacity. Hence the Base Exchange Capacity of a soil is the number of millequivalents of cations which the colloidal fraction (organic or inorganic) of 100 gms. of soil can adsorb. As the amount of material of colloidal size in a soil increases, the base exchange capacity also will increase accordingly.

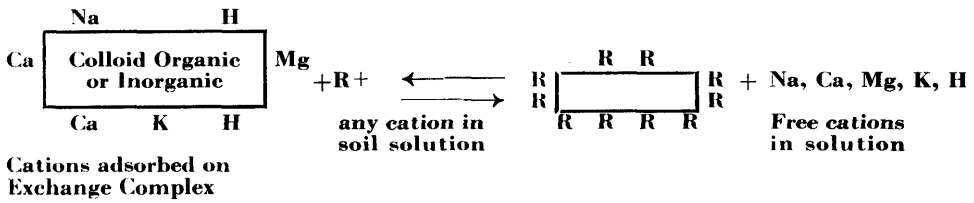


FIG. 9—Diagrammatic representation of base exchange reaction.

Per Cent Saturation

The per cent saturation with a cation (e.g. H^+, Ca^+, Mg^{++}, K^+) is a useful means of expressing the millequivalents of any one cation which are adsorbed by the colloid in relation to the total number which could be adsorbed (i.e. Base Exchange Capacity). For example, in Table 31 the per cent saturation with calcium indicates the proportion of the exchange capacity which is occupied by calcium.

In the soils of Grenville County it will be noted that the base exchange capacity may vary as much within the same series as it does between series. This condition is a result of the predominating influence of variations in organic matter content. However, in general the heavy textured soils have a higher base exchange capacity and hence a greater ability to hold readily available plant nutrients than do sandy soils.

It has been indicated by various investigators that the ratio of the cations to one another, i.e. Ca/K and Ca/Mg, may be of greater importance in soil plant relations than the actual total amount of a cation present. Until more information is available no further remarks can be made on this subject.

The medium and heavy textured soils have a high calcium content and hence the Ca/K ratios are wide. The high calcium content is expected since the underlying bedrock is limestone in nature. The Ca/Mg ratios are narrow in most cases, since magnesium is also present in quantity in the limestone.

The fact that the per cent saturation with calcium is more than 100 in many cases may be disturbing. However, this result is due to the fact that these soils contained free calcium carbonate which was not removed prior to determining the exchangeable bases. Hence some calcium which was not part of the exchange complex was determined as being exchangeable.

The optimum Ca/K ratios or Ca/Mg ratios for various crops are still in the controversial stage. It is possible that potassium is taken up by the plant more rapidly than calcium, especially in the early stages of growth. It has been shown that the uptake of potassium by plants from acid soils is increased by the addition of lime which automatically widens the Ca/K ratio. Thus, it would appear that a relatively wide Ca/K ratio is desirable.

Magnesium cations have a similar effect on potassium availability to that of the calcium cation. The effect of calcium and magnesium ions on each other is unknown.

The data in Tables 30 and 31 provide basic information as to the chemical characteristics of the soils of Grenville County. The results are included in the Soil Survey Report to be used as a guide in future fertility investigations in the area and as a basis for comparing the soils of Grenville County with other areas in the Province. The usefulness of the data undoubtedly will increase as our knowledge of soil-plant interactions grows.

TABLE 30

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

Series	Sample	Township	Con.	Lot	Sand	Silt	Clay	Reaction pH (Glass Electrode)	Phosphorus Readily Soluble[2]	Potassium Replaceable[3]	Calcium Replaceable[4]	Magnesium Replaceable[5]	Organic Carbon[6]	Organic Matter[7]
					Bouyoucos Hydrometer									
					Per Cent 1.0–.05 mm.	Per Cent .05–.002 mm.	Per Cent <.002 mm.		Lbs. P/ac.	Lbs. K/ac.	Lbs. Ca/ac.	Lbs. Mg/ac.	Per Cent	Per Cent C x 1.724
Allendale	4	Oxford	I	18	80.0	17.8	2.2	6.4	53	73	3480	230	2.5	4.3
	9	Oxford	VI	16	73.4	20.4	6.2	7.0	124	95	6600	930	3.0	5.3
	16	Edwardsburg	VIII	20	73.4	21.2	5.4	7.4	156	85	8000	650	2.3	4.0
	41	Augusta	V	9	85.0	12.2	2.8	6.9	57	61	4520	600	2.1	3.7
Carp	7	Oxford	III	11	55.8	21.2	23.0	7.7	348	218	11400	1145	2.6	4.6
	29	Wolford	A	27	39.6	39.6	20.8	7.2	214	263	9840	840	3.6	6.2
Granby	12	Oxford	VIII	18–19	44.2	43.0	12.8	7.9	404	93	24200	1850	3.2	5.6
	14	Edwardsburg	X	18	76.8	19.2	4.0	7.6	120	65	8280	650	3.2	5.5
	20	Edwardsburg	VI	7	67.4	28.4	4.2	7.8	258	81	12280	1025	4.1	7.0
	45	South Gower	VII	10	81.8	16.0	2.2	7.5	101	44	4360	485	2.2	3.7
	51	Augusta	V	32	84.8	13.6	1.6	7.1	272	61	8600	820	4.9	8.4
Grenville	2	South Gower	II	11	41.2	44.6	14.2	7.5	162	137	9320	1460	3.1	5.4
	3	Oxford	VI	24	43.2	39.8	17.0	7.5	60	143	7280	1415	2.6	4.4
	13	Oxford	VII	20	37.0	50.2	12.8	7.7	96	420	8640	2135	3.1	5.4
	17	Edwardsburg	VII	21	72.0	20.4	7.6	7.8	202	89	6400	885	2.0	3.4
	22	Edwardsburg	III	11	65.8	25.0	9.2	7.6	50	97	5280	1310	2.6	4.5
	26	Wolford	II	23	53.8	36.6	9.6	7.0	92	97	5080	840	2.5	4.3
	30	Wolford	A	N24	57.8	32.2	10.0	6.7	210	93	3320	1120	2.0	3.4
	34	Wolford	V	16	54.4	35.2	10.4	7.7	115	117	6960	1260	2.8	4.9
	38	Augusta	VII	13	68.6	25.8	5.6	7.3	46	198	5960	930	4.3	7.5
	40	Augusta	V	4	70.4	22.4	7.2	7.4	77	69	4080	1075	1.9	3.3
Kars	10	Oxford	VII	15	88.2	8.1	3.7	5.9	32	48	800	270	1.8	3.2
North Gower	19	Edwardsburg	VII	12	52.4	31.6	16.0	7.5	268	157	9920	1360	3.0	5.1
	50	Augusta	III	18	31.8	40.6	27.6	6.7	214	287	10280	2005	4.0	7.0

Manotick	15	Edwardsburg	VIII	14	80.0	15.4	4.6	6.1	36	93	2240	435	1.9	3.2
	18	Edwardsburg	VII	19	72.8	22.6	4.6	7.1	110	69	6920	885	3.2	5.5
	33	Wolford	IV	23	75.2	19.0	5.8	6.0	57	113	2400	555	2.1	3.6
	35	Oxford	I	4	84.2	13.0	2.8	6.1	54	65	2200	505	1.5	2.6
	49	Edwardsburg	III	1	81.4	14.8	3.8	7.8	113	61	7120	580	1.9	3.3
Matilda	6	Oxford	III	16	45.2	43.6	11.2	7.6	90	83	7040	1450	2.6	4.6
	32	Wolford	IV	24	57.0	31.6	11.4	7.5	137	93	5720	1310	2.2	3.8
	37	Augusta	VIII	12	57.4	34.0	8.6	7.7	95	77	7320	1120	2.6	4.4
Osgoode	8	Oxford	I	15	36.8	48.0	15.2	7.0	208	168	8340	1215	3.3	5.7
	24	Wolford	I	19	40.2	47.8	12.0	7.1	108	182	13640	1830	6.5	11.2
	25	Wolford	II	19	58.0	32.0	10.0	7.3	118	105	7360	930	2.9	5.0
	28	Wolford	A	30	60.4	25.4	14.2	7.8	156	129	9040	1450	2.0	3.4
	31	Wolford	II	25	46.4	33.2	20.4	7.0	336	214	12000	1595	4.3	7.5
	36	Augusta	X	13	55.0	31.0	14.0	7.8	480	97	14880	1170	3.7	6.4
	42	Augusta	VI	13	34.0	48.0	18.0	6.3	220	141	7840	1170	3.9	6.7
	43	Augusta	II	24	50.6	39.2	10.2	7.7	188	101	10640	1450	3.4	5.8
	46	South Gower	VIII	S½ 6	65.6	28.0	6.4	6.5	174	89	4720	630	3.5	6.0
Rubicon	1	South Gower	I	7	78.0	19.6	2.4	5.4	17	77	1400	115	3.0	5.2
	11	Oxford	IX	7	63.8	33.4	2.8	7.4	113	69	6720	670	2.6	4.5
	21	Edwardsburg	VI	6	81.6	16.0	2.4	6.9	40	77	4920	600	2.9	4.9
	48	South Gower	I	1	76.4	20.2	3.4	6.8	49	125	3520	485	2.4	4.2
Uplands	23	Edwardsburg	III	21	69.6	23.2	7.2	5.5	4	40	680	315	2.0	3.4
	39	Augusta	VIII	33	89.6	7.8	2.6	5.6	20	73	1440	460	2.3	4.0
	44	Augusta	II	11	83.3	13.1	3.6	6.1	91	65	840	410	0.9	1.6
	47	South Gower	VI	3	75.6	16.4	8.0	7.4	57	65	3080	820	1.3	2.2
Wolford	5	Oxford	II	9	60.2	32.2	7.6	7.7	38	166	8520	1350	3.3	5.6
	27	Wolford	II	26	51.0	35.2	13.8	7.4	192	109	5920	1215	2.4	4.2

(1) Samples were taken during course of the Soil Survey in 1944. Old pastures representative of the type were selected whenever possible. The analyses of mineral constituents and mechanical analyses were made by Dr. 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.

(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.

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

(5) The replaceable magnesium was determined on the filtrate from the calcium determination.

(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, Vol. 40, 1935, p. 311.

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

TABLE 31

BASE EXCHANGE CAPACITY [1] AND PER CENT SATURATION OF SURFACE SAMPLES FROM GRENVILLE COUNTY, ONT.

Soil Series	Sample No.	Base Exchange Capacity m.e./100 gms.	Per Cent Saturation				Ratios	
			$^2H+$	$Ca++$	$Mg++$	$K+$	Ca : K	Ca:Mg
Allendale	4	15.40	.....	60.4	53.2	2.8	21.2 : 1	1.1 : 1
	9	17.00	.....	104.1	27.0	1.7	59.5 : 1	3.8 : 1
	16	12.59	.....	123.9	21.2	0.6	196.2 : 1	4.7 : 1
	41	8.94	.....	193.4	44.7	1.0	177.0 : 1	4.3 : 1
Carp	7	22.46	.....	131.7	25.3	3.5	37.8 : 1	5.1 : 1
	29	24.37	.....	90.5	47.6	1.6	55.8 : 1	1.9 : 1
Granby	12	29.10	.....	130.0	46.0	1.0	123.6 : 1	3.8 : 1
	14	16.80	.....	120.6	18.4	0.5	226.2 : 1	6.5 : 1
	20	20.71	.....	132.0	16.4	0.4	320.0 : 1	8.0 : 1
	45	10.58	.....	106.1	64.6	1.1	96.5 : 1	1.6 : 1
	51	16.24	.....	125.0	30.2	0.3	402.0 : 1	4.4 : 1
Grenville	2	18.57	.....	122.7	59.5	1.1	107.0 : 1	2.0 : 1
	3	11.43	.....	144.3	47.3	2.1	66.3 : 1	3.0 : 1
	13	17.49	.....	101.9	36.1	2.8	35.8 : 1	2.8 : 1
	17	11.22	.....	139.9	27.6	0.8	157.0 : 1	5.0 : 1
	22	15.08	.....	88.9	35.8	0.9	96.9 : 1	2.4 : 1
	26	14.38	.....	91.4	58.7	0.8	105.3 : 1	1.5 : 1
	30	11.61	.....	93.8	13.7	1.2	76.7 : 1	6.8 : 1
	34	13.99	.....	121.6	56.5	1.2	95.5 : 1	2.1 : 1
	38	18.82	.....	74.2	60.5	1.4	57.6 : 1	1.2 : 1
	40	10.97	.....	88.0	65.0	1.1	79.9 : 1	1.3 : 1
Kars	10	4.72	4.7	61.4	27.5	3.6	16.6 : 1	2.2 : 1
North Gower	19	21.15	2.8	76.9	21.8	0.5	131.8 : 1	3.5 : 1
	50	29.27	.....	88.9	54.1	0.7	113.0 : 1	1.6 : 1

Manotick	15	9.21	.....	78.1	32.6	1.2	63.0 : 1	2.3 : 1
	18	17.09	.....	104.8	20.5	0.5	197.0 : 1	5.1 : 1
	33	9.10	.....	74.8	25.5	1.9	38.9 : 1	2.9 : 1
	35	7.58	.....	105.9	23.8	1.6	64.2 : 1	4.4 : 1
	49	10.42	.....	163.8	38.3	0.6	242.3 : 1	4.2 : 1
Matilda	6	15.10	.....	114.5	34.4	0.9	124.3 : 1	3.3 : 1
	32	14.87	.....	95.8	26.9	0.9	105.2 : 1	3.5 : 1
	37	13.50	.....	112.6	65.2	0.6	180.2 : 1	1.7 : 1
Osgoode	8	23.32	.....	95.3	29.1	1.0	64.5 : 1	3.2 : 1
	24	38.21	.....	87.7	29.1	0.5	155.8 : 1	3.0 : 1
	25	18.91	.....	104.1	56.2	1.0	100.7 : 1	1.8 : 1
	28	14.94	.....	154.8	90.5	1.2	121.0 : 1	1.7 : 1
	31	31.54	.....	100.8	44.7	0.9	105.5 : 1	2.2 : 1
	36	20.03	.....	186.8	31.5	0.7	243.8 : 1	5.9 : 1
	42	23.16	.....	80.5	59.2	0.9	81.8 : 1	1.3 : 1
	43	19.11	.....	106.8	29.3	0.7	134.2 : 1	3.6 : 1
	46	14.94	.....	81.9	60.2	0.8	100.2 : 1	1.3 : 1
Rubicon	1	10.43	17.2	46.0	32.5	3.8	12.0 : 1	1.4 : 1
	11	12.62	.....	136.2	28.5	2.1	64.3 : 1	4.8 : 1
	21	15.39	1.9	86.0	13.0	0.5	149.8 : 1	6.6 : 1
	48	9.61	.....	81.1	94.8	1.7	46.6 : 1	0.8 : 1
Uplands	23	8.27	12.9	65.5	21.8	0.8	74.2 : 1	3.0 : 1
	39	7.50	34.6	50.7	13.3	1.6	30.0 : 1	3.0 : 1
	44	3.61	.....	77.8	72.0	2.9	26.7 : 1	1.0 : 1
	47	9.48	.....	89.8	67.6	1.2	68.6 : 1	1.3 : 1
Wolford	5	15.62	.....	123.5	113.0	3.8	31.5 : 1	1.1 : 1
	27	15.80	.....	111.6	65.2	0.9	113.3 : 1	1.7 : 1

(1) Method proposed by Schollenberger, C. F., and Simon, R. H., Soil Science 59 : 1, 1945, "Determination of Exchange Capacity and Exchangeable Bases in Soil, Ammonium Acetate Method." The alternate method was used on the Grenville County soils in which the soil is leached with 1N KCl.

(2) By difference.