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Pleistocene Geology of the Scarborough Area

by

P. F. Karrow

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ABSTRACT

The Scarborough area is on the north side of Lake Ontario at the east end of the city of Toronto. The bedrock is dark shale of Upper Ordovician age; outcrops of it are found along the lower valleys of the Rouge River and Little Rouge Creek. Pleistocene deposits 100–400 feet thick conceal the bedrock surface; few wells extend into bedrock.

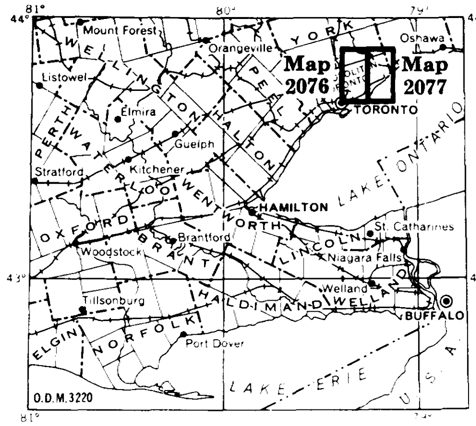

Figure 1—Key-map showing location of the Scarborough area. Scale, 1 inch to 50 miles.

The Pleistocene sequence includes Illinoian(?) till, Sangamonian(?) interglacial Don Formation (warm-climate wood and shells), early Wisconsinan Scarborough Formation (clay and sand with cool-climate plant remains), Sunnybrook Till (early Wisconsinan), interstadial Thorncliffe Formation (clay and sand with sparse plant remains), two apparently minor till-sheets (Seminary Till and Meadowcliffe Till) interbedded with the Thorncliffe Formation, and Leaside Till (late Wisconsinan, including Tazewell to Mankato). Postglacial lakes include Lake Iroquois; this cut a prominent shorecliff across the area about 200 feet above Lake Ontario. Modern erosion by Lake Ontario has created the Scarborough Bluffs in which excellent exposures of the Pleistocene beds may be seen.

Urban expansion has greatly reduced the sources of sand and gravel. Gravel is found in beach ridges of Lake Iroquois and as kame deposits covered by Leaside Till. The beach deposits are almost depleted. Future sources will have to be found outside the area. Expanding construction activity requires increasing knowledge of the soils of the area. Shore erosion is an existing problem that can be solved only in a long-term approach.

Pleistocene Geology of the Scarborough Area

By

P. F. KARROW[1]

INTRODUCTION

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Photo 1—Scarborough Bluffs at Cathedral Bluffs Drive. The cliffs rise almost 300 feet above Lake Ontario.

Location and Access. The area included in this report consists of all of Scarborough Township in York County and parts of Markham Township (York County) and Pickering Township (Ontario County). The area is covered by parts of the following topographic sheets at a scale of 1 to 25,000 published by the Army Survey Establishment: 30M/14c (Agincourt), 30M/14b (Highland Creek), 30M/11f (East Toronto), and 30M/11g (Scarborough). Parts of National Topographic Series sheets 30M14 (Markham) and 30M11 (Toronto) also cover the area at a scale of 1 to 50,000.

[1]Geologist, Ontario Department of Mines, Toronto.

Scarborough area

The report-area extends from Lat. 43°52'30"N to Lake Ontario, and from Long. 79°07'30"W to the west boundary of Scarborough Township and Long. 79°22'30"W. It is situated in southern Ontario on the north shore of Lake Ontario. The total land area of 113 square miles consists of 73 square miles in Scarborough township, 30 square miles in Markham township, and 10 square miles in Pickering township.

The rural part of the area is crossed by a grid of roads at 1¼-mile or ½-mile intervals; a number of these are paved. Provincial highways Nos. 2, 5, 7, 48, and 401 cross the area. A large part of the area has been subdivided for suburban housing development and is completely accessible. Several lines of the Canadian National Railways and the Canadian Pacific Railway serve the area.

Field Work. The mapping of the Scarborough area was undertaken for several reasons. The author's attention was drawn to the numerous sections exposed in the river valleys during a reconnaissance study of the Newmarket and Markham areas in August 1957. Rapid encroachment by suburban housing developments was continually making it more difficult to carry out geological work in the area, so delay in its undertaking meant a loss of information. The northern and western parts of Metropolitan Toronto had already been mapped for the Ontario Department of Mines by A. K. Watt, leaving only Scarborough on the east to complete a belt of detailed mapping around the Metro area. The hope in carrying out this work is that it will salvage information soon to be lost through urbanization, extend previous geological knowledge of the renowned Pleistocene geology of the Toronto district, and provide information of use to engineers, planners, and citizens interested in the natural history of the area.

Field work in the area was carried out in three phases[1]: during the early part of the summer of 1960 the stratigraphy of exposures along the river valleys was studied and about 10,000 feet of stratigraphic section was measured; in the early part of the summer of 1961, another 5,000 feet of stratigraphic section in the lake bluffs was measured and, concurrently, the areal distribution of deposits was mapped. Many of the valley sections were so steep that the use of a climbing rope was necessary.

Information on the areal distribution of deposits was gained by drilling holes with a hand auger and by the examination of road cuts, stream banks, building excavations, and sand and gravel pits. The information thus gained was plotted on base maps at a scale of 1 to 15,000. Aerial photographs were used extensively as an additional tool.

A preliminary account of the results of the field work was published in 1962 as O.D.M. Preliminary Report 1962-1.

Generally only surface deposits 3 feet or more in thickness have been mapped. Map units have been selected on a basis of lithology and age.

Population. Situated on the edge of Metropolitan Toronto, the area has undergone rapid development and increase in population in the last few years. Table 1 illustrates this with figures for two incorporated municipalities in the area.

[1]The date of 1963 shown on maps 2076 and 2077 is incorrect.

Table 1 *Population within the map-area*

	1941	1951	1956	1961	1963
Village of Markham	1,204[1]	1,606[1]	2,842[1]	—	5,265[2]
Township of Scarborough	24,303[2]	56,292[2]	—	217,286[2]	240,371[2]

NOTES:

[1]Canadian Almanac and Directory, Copp Clark Co., Toronto.
[2]Statistics of Ontario Dept. Municipal Affairs.

Scarborough township has an area of 73 square miles and a population of 240,371; although its average population density is almost 3,300 people per square mile, the population is at present concentrated in the southwestern part of the area, next to the City of Toronto and along Lake Ontario.

Industry and Commerce. A great many small industrial plants are situated in the southern part of the area, producing a wide variety of manufactured goods. The northern part is still mainly rural. Much good agricultural land exists but it is steadily diminishing in area. Annually, large areas are subdivided for suburban residences and shopping centres.

Climate. Data from the Meteorological Branch of the Canada Department of Transport for Agincourt (Ont.), compared with Toronto and Malton (Ont.), are given in Table 2.

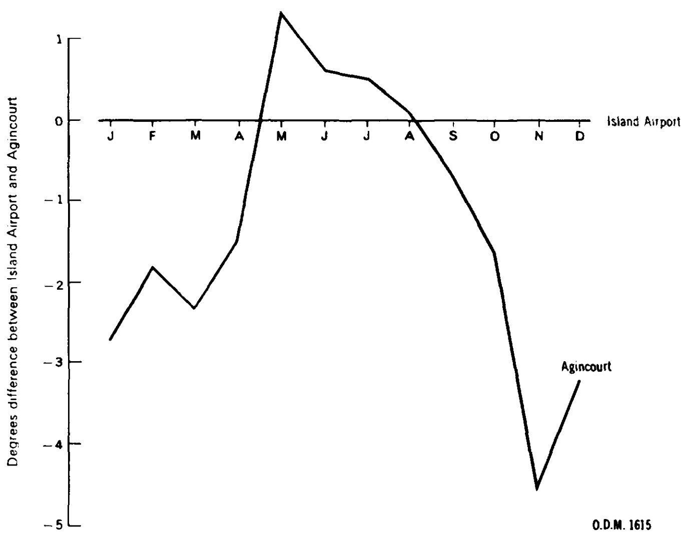

Figure 2—Comparison of monthly mean temperatures.

Table 2 *Annual precipitation and temperature averages*

	Precipitation (inches)			Temperature (Farenheit)		
	Total	Rain	Snow	Maximum	Minimum	Mean
Toronto	30.56	25.07	54.9	55.4°	39.8°	47.6°
Malton	30.52	24.91	56.1	54.7°	35.8°	45.3°
Agincourt	31.20	25.55	56.5	53.7°	37.0°	45.4°

In 1961 rainfall over the report-area varied from 33.51 to 27.86 inches. Lake Ontario has a modifying influence on temperatures, particularly in winds from the south; temperatures near the lake are lower in summer and higher in winter than inland (see Fig. 2).

Topography. Scarborough township is on a broad crest of high land projecting southward from an elevated plain north of Toronto. This is the only area where the 500-foot contour reaches the Lake Ontario shore.

The highest elevation in the area is about 700 feet above sea-level; this is at the top of a hill on the north edge of the area about two miles northwest of Unionville. Another high area has a crest elevation of 670 feet 2 miles south of Unionville and then slopes gently southward and eastward to the old shorecliff of Lake Iroquois. The top of this shorecliff varies from 450 to 600 feet in elevation.

South of the old shoreline is a relatively flat plain which has an elevation of 440 feet in the southwest, 470 feet in the northeast, and then sloping down to the south and east. Along the Lake Ontario shore are steep cliffs which are 150 to 180 feet high for the most part, but reach to over 300 feet at their highest point, and diminish to almost nothing near the mouths of Rouge River and Highland Creek.

The southern edge of the mapped area is at the shoreline of Lake Ontario, whose elevation is 246 feet above sea level.

Drainage. The presence of a high upland close to the lake has caused streams to cut deep youthful valleys. All the streams in the area flow into Lake Ontario.

A small area between Birch Cliff and Wexford is drained by Massey Creek, a tributary of the Don River. It has its source north of Wexford at an elevation of about 570 feet and leaves the area, about 7 miles down stream, at an elevation of 340 feet near Danforth Avenue — an average gradient of 33 feet per mile.

A small area near Amber (southwest of Unionville) is drained by a tributary of the Little Don River. It drops from about 510 feet elevation to 470 feet along the 1½-mile portion of its course in the area.

Highland Creek drains the central part of the area lying between Wexford, Milliken, and Port Union. The several tributaries head at elevations varying from 590 to 650 feet; the main branch heads near Milliken. Highland Creek has an average gradient of about 25 feet per mile. It has a small flood plain and many minor meanders in the lower part of its course; its mouth, just west of Port Union, is marshy.

The Rouge River is the major stream of the area, entering near Buttonville, in the northwest, at 630 feet, and reaching Lake Ontario just east of the map area at Rosebank Station. It has an average gradient of about 22 feet per mile and has some flood plain along most of its length. The Rouge, and its main tributary Little Rouge Creek, drain the northern and eastern part of the map-area. Little Rouge Creek enters the area north of Cedar Grove and joins the Rouge River at Rouge Hill a mile inland from Lake Ontario.

Petticoat Creek rises near the northern boundary of the area at about 620 feet and drops 300 feet in 5 miles to near Rouge Hill where it leaves the area. A short segment of West Duffin Creek also crosses the northeast corner of the area at Clarkes Hollow. In 1½ miles it drops from an elevation of 540 feet to 410 feet.

Numerous springs have their origin in the bluffs along the lake where permeable water-bearing beds overlie impermeable clay or till layers. Some of these springs have eroded headward to create some of the ravines along the shore. Other ravines are the result of surface runoff. All the ravines are steep-walled V-shaped valleys with very steep gradients; the heads of some of them are amphitheatre-shaped or cirque-like. Small waterfalls are common in the ravines where resistant clay or till beds interrupt the downward course of the water.

Previous Work. The geology of the Toronto district has received a great deal of attention over the last 100 years; this is particularly true of the Pleistocene beds, which have achieved international fame for the unique features they exhibit. Recognition of the interest they have aroused resulted in the Ontario Department of Travel and Publicity erecting a plaque at Scarborough Bluffs.

A selected bibliography has been assembled on the geology of the Toronto area and is included at the end of this report. It was formerly a common practice to publish the same paper in several journals; this kind of repetition has mostly been eliminated from the present bibliography. As far as possible, original sources were consulted. The selection of references is necessarily a somewhat subjective one; but it is hoped that no important items have been overlooked. Probably, in fact, the bibliography is fairly complete.

A summary of some of the high points of the various studies will be given here.

Fleming, in 1853, deduced that Toronto Island was formed by the combined effects of the erosion of Scarborough Bluffs and deltaic sedimentation by the Don River. A later paper (1861) on the Davenport gravel ridge suggested that Lake Ontario had eroded a cliff and built a bar when the water stood at a higher level; included in the paper was a drawing showing the former extent of the higher water in the vicinity of Toronto.

Murray (1854) described clay pits on the second concession of York, lots 19 and 20, which showed red-burning over white-burning clay down to a depth of 75 feet. Logan (1863) also reported on thick clay deposits at Toronto and classified them as an upper unit, the Saugeen clay, and a lower unit, the Erie clay; mention was also made of shell-bearing beds on the banks of the Don River.

Mastodon or mammoth remains were soon discovered near Toronto in the old lake beaches and in buried strata. These and other mammal remains were described in papers by Winchell (1863), Bensley (1913; 1923), and Sternberg (1930).

Scarborough area

In 1877 Hinde described the strata exposed in Scarborough Bluffs. This outstanding paper records striae bearing northwest on the bedrock and on boulder pavements within boulder clay west of Fort York; this was regarded as the oldest till in the area. Overlying this was interglacial fossiliferous clay which he correlated with similar clay in Scarborough Bluffs. He noted layers of plant remains in the clays and overlying interglacial sand at Scarborough and listed diatoms, algae, wood, leaves, seeds, snails, insects, and two or three species of ostracods as being present. He concluded that all the fossils were land or freshwater forms and indicated the former presence of a lake in the Ontario basin.

On top of these beds he found a second till layer which filled an ice-eroded valley cut in the clays and sands below. In the residual hollow in the till over this valley were laminated clay and sand, with no fossils, of a second interglacial stage. On top of the section was a third till deposited by ice from the northeast.

Postglacial sand and gravel, he believed, had been deposited by a lake 200 feet higher than Lake Ontario. A very significant point is that he believed that the till had been deposited by glacial ice, rather than by floating icebergs. The iceberg theory was a popular one in the nineteenth century, as is seen by the references to it by numerous authors, among these Chapman (1861). It was in connection with this theory that glacial deposits became known as "drift".

In two papers, J. W. Spencer (1888; 1890) described a deep-buried valley joining Georgian Bay to Lake Ontario a short distance east of Toronto. He postulated that the Great Lakes had once drained along this channel to the St. Lawrence valley and that drift in the high ridge south of Lake Simcoe must be over 700 feet deep. In another paper (1889), he named the Iroquois Beach and Lake Iroquois; by taking elevations at various points on the old shoreline he discovered that the basin was tilted up higher to the northeast. He concluded that Lake Iroquois was postglacial and younger than Lake Warren (which he also named) of the Erie basin.

Most of the plant remains found in the interglacial beds by Hinde, Townsend, and Coleman were studied by Penhallow; he described what he thought were two extinct species of maple trees, along with an abundance of other plants. Many years later, Brown (1942) disputed this identification, and demonstrated that Penhallow's "maples" were in fact *Platanus*. Dawson and Penhallow (1890) correlated the Toronto section with marine beds of the St. Lawrence valley and described the plant remains found in the two series of beds.

The name most widely associated with Toronto Pleistocene geology is that of A. P. Coleman who wrote many papers on the subject over a period of 45 years. He studied the Bluffs and new exposures in the Toronto area, particularly those along the Don River in cuts and brickyards. Coleman's long-continued attention to the exposures and his energetic field work added a great wealth of detail on the interglacial beds. His numerous publications brought world-wide attention to the deposits.

In his first paper in 1894, he reported on the recently exposed interglacial beds in the Don Valley and listed three kinds of wood and 16 kinds of molluscs as indicating a warm climate. An underlying till he erroneously correlated with the lowest till in the Bluffs and he assumed the warm-climate beds were equivalent to the varved clays in the Bluffs; this suggested that the Don beds were younger than the Scarborough beds.

In another paper the next year he listed 29 extinct species of beetles in the Scarborough beds indicating a cool climate and he revised his till correlation, placing an upper till in the brickyard as equivalent to the lower till of the Bluffs; the relative ages of the Don and Scarborough beds were then left unknown. At the same time he expressed the opinion that the sea had never entered the Ontario basin in postglacial times. In 1899 he presented firmer evidence to support this view.

Simpson (1893) and Scudder (1895) reported on the interesting finds of molluscs and beetles from the interglacial beds. Chamberlin, in 1895, applied the name "Toronto Formation" to the interglacial deposits.

A meeting of the British Association for the Advancement of Science was held in Toronto in 1897 and, their interest aroused in the interglacial beds, they advanced a sum of £20 to be spent on collecting more fossils for determining more accurately the ancient climate and on determining the relative age of the Don and Scarborough beds. The reports of a special committee under the chairmanship of Sir J. W. Dawson summarized the results of the investigations in 1899, 1900, and 1901, an additional sum of £25 being granted in the meantime. The sinking of wells on the beach at the Bluffs and at the brickyard revealed that the Don beds were under the Scarborough beds and increased the list of fossil plants and animals nearly to its present length.

In 1901, Coleman again summarized the state of knowledge of Pleistocene deposits in Toronto, referring to four tills in the Bluffs. He concluded that the interglacial deposits were laid down at Toronto between the Iowan and Wisconsin ice advances. Later papers on the Toronto region by Coleman appeared in 1902, 1913, 1914, 1925, 1932 (the most complete), and 1936. His final publication, which appeared posthumously in 1941, contains a summary of Toronto Pleistocene deposits. Other papers by Coleman on Lake Iroquois and other water levels in the Ontario basin appeared in 1904, 1922, and 1936; the most detailed being that of 1922. He came to agree with Fairchild (1907) that a body of water at sea level (named Gilbert Gulf by Fairchild) probably did exist in the Ontario basin (but kept fresh by inflow from rivers), and he identified its shoreline in the Belleville area of eastern Ontario, saying that it sloped down to the west below present lake levels. Recently Mirynech (1962) has disputed this and states that the beach referred to is a freshwater level. Coleman, in the same paper of 1922, gave the name "Admiralty Lake" to a postglacial low-water stage in the Ontario basin.

Wilson, in an important paper in 1905, described the fine exposures showing three till sheets in high shore cliffs at Newcastle. In 1901 he showed that three tills were traceable from Burlington to Presqu'ile. Coleman (1909) correlated these exposures with the Toronto section, placing the Toronto Formation between the Illinoian and Iowan tills; and a second interglacial, the deposits of which were named the "Clarke" sands and clays (named after Clarke township), was placed between the Iowan and Wisconsin ice advances. As the thinking of glacial geologists changed, and the Iowan came to be considered only a substage of the Wisconsin, Coleman pushed the age of the Toronto beds back to the Yarmouth interglacial stage.

The economic geology of the area received attention with the publication of a report on the clay and clay industry of Ontario by M. B. Baker in 1906. He used Logan's classification of clays as Erie and Saugeen types but refined the definitions somewhat. A later report by Keele (1924) discarded this classification and adopted a modified version of Coleman's classification, reducing the Clarke sands from interglacial to interstadial rank and lumping all the deposits above the Scarborough beds into the Wisconsin stage; the oldest till he assigned to the Illinoian.

Both Baker and Keele described the local use of clay and shale in the ceramic industry. Montgomery summarized the ceramic industry again in 1930. The sand and gravel industry was reported on by Ledoux in 1918; operations then active were described briefly. The Ontario Department of Mines has undertaken extensive new studies of the clay and gravel industries (Hewitt and Karrow 1963).

In 1920, De Geer led a Swedish expedition to America to study varved clay chronology. Under his guidance, Antevs and Liden measured the Toronto varves hoping to learn the length of time that had elapsed since glaciation, as De Geer had succeeded in doing so well in Sweden. De Geer published his conclusions in 1926, correlating the Toronto varves with postglacial varves in Sweden. Antevs published a detailed study of the Toronto varves in 1928. Coleman (1929) invalidated De Geer's correlation by pointing out that the Toronto varves are much older than the Swedish varves and are overlain by glacial till.

Groundwater investigations in suburban areas and new subway construction in the central part of the city led to additional studies by Watt. He discussed the Yonge subway in 1954; his report on North York township was released in 1957; in this report and the accompanying list of Selected References, it is referred to as "Watt 1955". Pollen studies of the Don and Scarborough beds were carried out by Terasmae and published in 1960. Watt considered the Toronto Formation to be of Sangamon age and Terasmae applied names to the various lithologic units exposed in the Don brickyard and Scarborough Bluffs.

A paper by Dreimanis and Terasmae (1958) provided new correlations for the Toronto section on the basis of a mineralogical analysis of tills. Tills above the Scarborough beds were assigned to early and late Wisconsin substages covering a time interval of about 70,000 years.

The bedrock geology of the Toronto area is concealed by thick Pleistocene deposits; consequently it has had a much less varied history of research. Probably the most extensive studies were those by Parks (1923, 1924a, 1924b, 1925, 1928), Parks and Dyer (1921), and Parks and Fritz (1922); with additional studies by Dyer (1923a, 1923b), Fritz (1923, 1946a, 1946b, 1951), and Foerste (1916, 1924).

Classification and correlation of the Paleozoic rocks near Toronto have been hindered by limited exposure; subdivision has been largely based on fossil content although these criteria are not now considered appropriate for dealing with lithologic units. A regional study by Caley (1940) was the latest to use the older terminology. A major revision and classification was undertaken by Liberty (1953, 1955) based on the lithology of the rock units. Gorrell (1952) made a study of the shale exposures in the Yonge subway. Subsurface studies of the Cambrian by Sanford and Quillian (1959) and of the Ordovician by Sanford (1961) cover the Toronto area.

Economic geology of the Paleozoic rocks has been mostly covered by reports on clay and shale. A report by Hewitt (1962) outlines the problems of mineral exploitation in urban areas.

Natural Resources. Wooded areas are now mainly confined to low poorly drained depressions, floodplains and young stream terraces, and steep valley sides; they cover only a small fraction of the area mapped. Nevertheless, there is a considerable variety of wildlife in the area, particularly in the relatively secluded valleys. Among the larger animals observed during the course of field work were deer, muskrat, and racoon.

In the last century, water power was a valuable resource of the area and many mills were established along the courses of the larger streams, particularly the Rouge. More details on this can be found in the conservation report on the Rouge, Highland, Duffin, and Petticoat drainage basin (1956). The old mills have almost all disappeared.

In former times the sand and gravel industry was a major operation in the area, exploiting the beach deposits of Lake Iroquois, whose shoreline crosses the area. More recently, buried deposits have been found which are being exploited at the present time.

Acknowledgments. Field assistance in 1960 was provided by R. C. Ostry, R. C. Brown, and D. L. Shorten; and in 1961 by R. C. Ostry, D. L. Shorten, and G. D. McKenzie. Most of the areal mapping was carried out by R. C. Ostry.

Additional information was supplied by the Metropolitan Toronto Works Department, Township of Scarborough Works Department, Racey MacCallum and Associates Limited, Ontario Water Resources Commission, and the Geological Survey of Canada.

Field discussions with J. Terasmae and E. Mirynech of the Geological Survey of Canada, A. Dreimanis of the University of Western Ontario, C. S. Churcher and R. E. Deane of the University of Toronto, and R. E. Wicklund of the Canada Department of Agriculture, contributed to a better understanding of the problems of the area.

Fossils were identified by F. P. Ide and C. S. Churcher of the University of Toronto, J. Terasmae and R. J. Mott of the Geological Survey of Canada, A. H. Clarke Jr. of the National Museum of Canada, H. B. Herrington, of Westbrook (Ont.), and J. Oughton of the Ontario Agricultural College. Laboratory analyses were carried out by the Laboratory Branch, Ontario Department of Mines.

The extensive use of library facilities at the Royal Ontario Museum was a most valuable aid toward compiling the bibliography.

The residents of the area generously provided access to their property on many occasions.

Paleozoic Geology

Ordovician. Only a few bedrock outcrops are known to occur in the area. These are located along the Rouge River and Little Rouge Creek intermittently for a distance of 1¼ miles northwest of Highway 2. Outcrops shown by Coleman as occurring south of Highway 2 are now obscured.

Scarborough area

As exposed in the outcrops, the bedrock is mostly a grey to nearly black non-calcareous shale. In one exposure, pyritized fossils were seen, and, in another, 1-inch-thick crossbedded arenaceous beds occurred at 1- to 2-foot intervals. Outcrops are generally less than 10 feet high above river level; shale forms the stream bed of Little Rouge Creek near Twyn Rivers Drive and of the Rouge River just north of the Highway 2 bridge.

The most recent study of the bedrock of the area is that by Liberty (1953, 1955, 1964); he has reclassified the outcropping rocks as the Whitby Formation (Upper Ordovician). These shales were previously classified by Caley (1940) as Billings Formation.

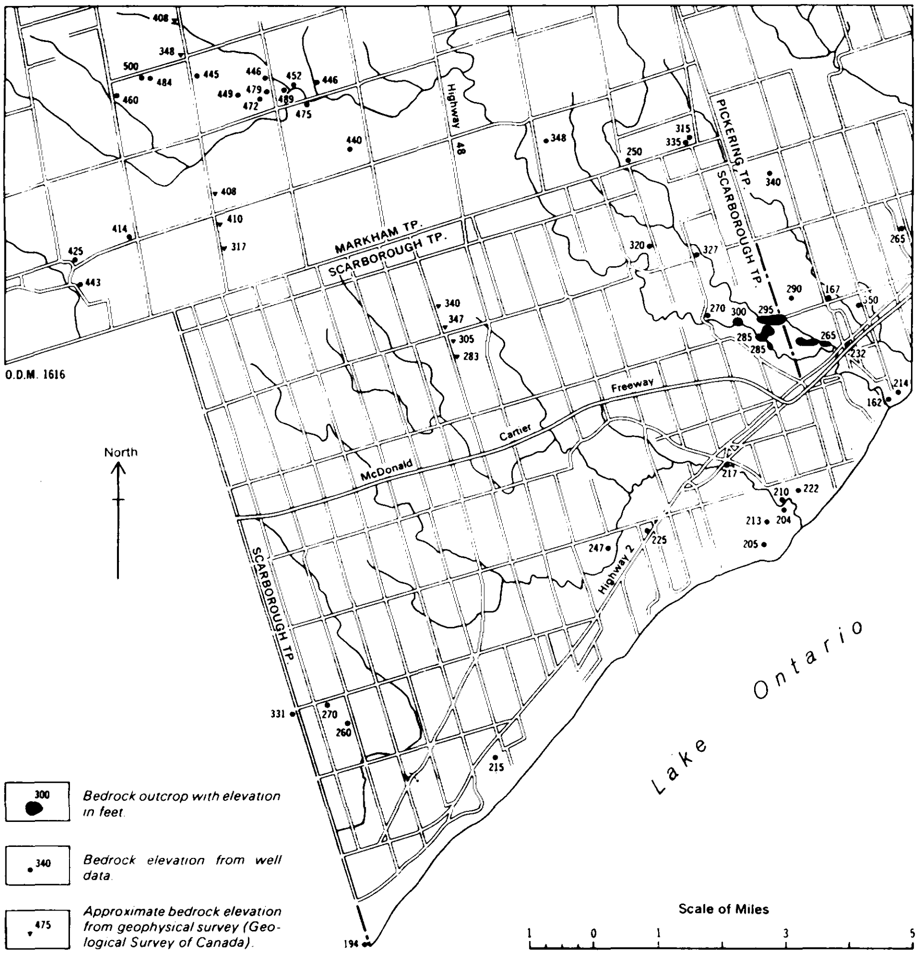

Figure 3—Bedrock elevations.

Bedrock Topography. The Pleistocene deposits are so thick in the area that little is known about the form of the bedrock surface. The sparse data that are available, mainly from water wells, is shown in Figure 3. Most of the data are from Markham township and the eastern part of Scarborough township.

The data available show a variation in bedrock elevation of from about 200 feet near the lakeshore to 500 feet near Buttonville. Elevations vary about 50 feet in a distance of a half mile. There is insufficient data to construct a meaningful bedrock contour map. Major relief features in the bedrock surface no doubt exist, as shown in North York Township by Watt (1955), to the west of the report-area.

Drift thickness varies considerably. The highest part of the Bluffs is nearly 350 feet above the lake and, with bedrock averaging 30 to 50 feet below lake level, a total thickness of nearly 400 feet must exist in that area. Coleman (1932) reports that a well at St. Augustine's Seminary penetrated 330 feet of drift. The bedrock surface rises to the north more rapidly than the land surface so that drift thickness diminishes, except over buried valleys, west, north, and east from the crest of the Scarborough Bluffs. Thicknesses of less than 200 feet are general in the northern and eastern part of the area.

PLEISTOCENE GEOLOGY

Geomorphology

General. The regional physiographic features have been described by Chapman and Putnam (1951). The location of this report-area and its small size result in a relatively restricted variety of landforms being included in the area. Three of Chapman and Putnam's minor physiographic regions cover the area: Iroquois plain, south slope, and Peel plain. In this present report, smaller features will be discussed in their presumed order of development from oldest to youngest.

Till Plain

Most of the report-area consists of till plain. In part it has an irregularly undulating to rolling surface, in part it has been formed into low drumlins, and in part it has an ice-fluted surface. Throughout most of the area it is possible to tell the latest direction of ice movement from these features; in all cases ice moved northwest out of the Lake Ontario basin. In general, the ice-flow features tend to be more elongated in the south and east, and broader and more rolling to the north.

The main till plain lies between the Lake Iroquois shoreline on the south and the boundary of the mapped area to the north and west. Fluting is best developed in an area south of Highway 401 and southeast of Agincourt (see Photo 2). It is similar to that described by Watt in North York township (1955) and by the author in the Hamilton area (1963). No doubt, suburban development has concealed additional areas of fluted till plain as it is now in the process of covering the area southeast of Agincourt.

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Photo 2—Vertical photo showing fluting in the till plain southeast of Agincourt. The cloverleaf at the upper right is the intersection of Markham Road (Highway 48) and Highway 401. (Photo courtesy of Ontario Dept. Lands and Forests.)

A second and much smaller area of till plain occurs southeast of the Lake Iroquois shoreline north of Port Union. This area was flooded by the waters of Lake Iroquois but, being well below wave-base, the till surface was largely unmodified. Here, too, linear forms on the till surface record ice movement out of the Ontario basin. The preservation of these features is best near the present lakeshore, i.e. at lower elevations, except for the masking effect of lake clays which occur in some of the depressions.

As will be seen in the accompanying geological maps and sections of the Bluffs, the till which forms the till plain is the Leaside Till. The surface features, almost without exception, owe their origin to the processes which led to the deposition of the till sheet. This till apparently truncates earlier topography.

Drumlins

A wide variety of drumlin shapes is present in the map-area. They constitute the major landform composed of till. Discrete drumlin forms are often difficult to identify since they form part of a gradational series ranging from low rounded swells in the till plain, through fairly well-formed oval-shaped drumlins (in form like an inverted teaspoon bowl), to narrow, steep-sided, long, ridges, which gradually blend into flutings on the till plain.

Most drumlins are between 20 and 50 feet high, ¼ to 1 mile long, and ⅛ to ¼ mile wide. The bearing of their long axes varies from 133° in the southeast, to 150° in the northeast, to 136° in the northwest, and to 127° in the southwest; this pattern is a fanning-out from the Ontario basin onto the higher ground northwest of the lake. The pattern noted here is typical of the pattern farther to the east and west of the report area; east, toward Oshawa, the trends become more nearly north-south, while to the west, near Hamilton, they trend nearly east-west.

The 10-foot contour interval on the 1-to-25,000 topographic sheets shows the shapes and trends of most of the drumlinoid features. These features controlled the development of the present drainage pattern in the portions of the report-area underlain by till plain. Minor streams follow the flutings and depressions between drumlins while major streams follow the same general trend. No doubt the larger streams established their present channels as consequent streams on the till plain shortly after ice-retreat uncovered the area.

Moraines

Taylor (1913) showed a subdued, waterlaid, end moraine, which he called the Scarborough moraine, as trending through the area just north of the Iroquois bluff and shoreline. Chapman and Putnam (1951) concluded that no such moraine exists, pointing out that the area shown as moraine by Taylor is drumlinized.

The resolution of the conflict is not easy. Drumlins do commonly extend into the area of the supposed moraine. At the same time, there does seem to be a greater irregularity to the land surface along the belt of land just north of the Iroquois bluff. Perhaps the matter can be dismissed by assuming that a halt in ice retreat did occur but it was so brief as to be inconsequential. Sensitive adjustment of the shape of the ice front to topography is not surprising in itself. The development of a weak moraine having a re-entrant around the Scarborough highland, and the former existence of a prominent headland extending into Lake Iroquois, only serve to emphasize the physiographic importance of the highland, which owes its origin to much earlier events.

The author considers that any moraine which was formed in this map-area is too weakly developed to delineate and is relatively unimportant in the history of the area.

Outwash Plains

Only rather small areas of outwash sediments exist in the report-area. This is because the ice melted back downslope into the Ontario basin, ponding meltwaters in front of itself to the north, so that little stream action was possible beyond the ice front.

Sediments which might have originated as outwash are restricted to small areas of level to rolling sand near Cherrywood in the northeastern part of the report-area. These deposits were likely deposited, at least partially, in standing water in temporary lakes.

Photo 3—Section through Lake Iroquois shorecliff and terrace at the Seminary gulle
stratified peaty sand of th

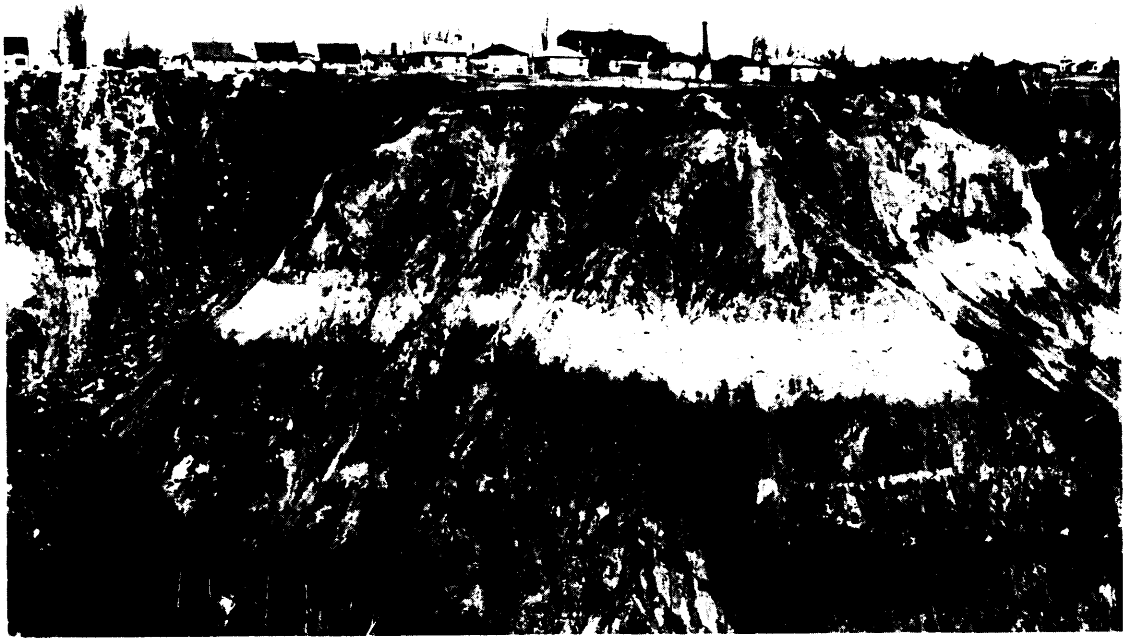
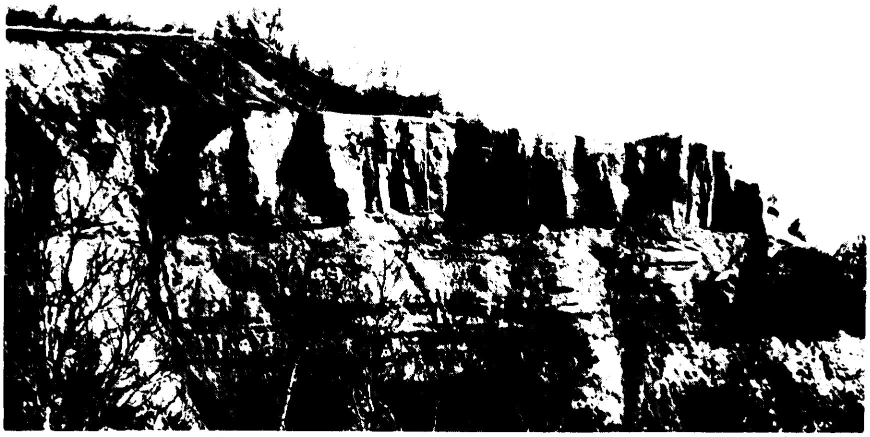


Photo 4—Ravine east of Sunnybrook Crescent along Scarborough Bluffs. Erosion of thic



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ıe massive jointed bed extending to the right is the Sunnybrook Till that rests on
arborough Formation.

ODM7003

nted till layer (Meadowcliffe Till) has resulted in a series of spires on the ravine wall.

Lacustrine Plains

There is one major lake plain in the area, that of Lake Iroquois; and several small ones, which may be related to one lake or several lakes at different levels.

In this area, the Lake Iroquois plain is not very wide, varying from zero to just over 1 mile wide in the southwest and up to 2½ miles wide near the Rouge River in the northeast. The boundaries of the Iroquois plain have been set somewhat arbitrarily on the north at the base of the Iroquois bluff and on the south at the apparent limit of the levelling action of Lake Iroquois waves. South of this line, which is just south of Kingston Road near the Rouge River, the drumlinized till surface was below wave-base and was little affected by wave erosion. This level is about 80 to 90 feet below the final level of the waters of Lake Iroquois, as measured at the base of the Iroquois bluff. In the central and highest part of the Scarborough Bluffs, modern erosion by Lake Ontario has cut away the Iroquois plain in front of the old headland, so that the present height of the Bluffs there is the height of the Bluffs to the east or west, plus the height of the Iroquois bluff.

The Iroquois plain is mostly underlain by shallow water sediments such as stratified fine silty sand and gravel. A small area underlain by varved clay and stratified silt near Port Union is probably attributable to Lake Iroquois or a short-lived successor; they likely represent deep-water sedimentation which partially filled the depressions between drumlins. If laid down in Lake Iroquois, the depth of water when they were deposited must have been over 150 feet.

The next most significant area of lake plain is that near Buttonville and Unionville, in the northwest corner of the area. Actually, much of this area of lake deposits has a rolling surface, no doubt reflecting the topography of the underlying till. Most of these deposits are to be found between elevations of 580 and 650 feet; they are confined to the broad depression in which the Rouge River flows, west of Markham. This basin must have been occupied by a short-lived lake, since no shore features have been identified. It may have been part of the extensive body of water, called Lake Peel, which has been described in the district north and west of Toronto by Chapman and Putnam (1951). On the other hand, since it lies considerably east of the Trafalgar moraine, it seems more probable that it is younger than Lake Peel, because there is evidence in the Hamilton area (Karrow 1963) to indicate that Lake Peel was drained about the time the ice retreated from the Trafalgar moraine. No comparison of the levels of the two lakes is possible at present. This lake plain is older than shore features described by Watt (1955) in North York township at 525 and 475 feet elevation.

The silts and clays in the lower part of the basin west of Unionville are covered by sand. The origin of the sand is uncertain but it is younger than the clay and was probably deposited by streams as the lake was drained, or soon after.

Numerous small pockets of lake or pond deposits are to be found scattered throughout the till plain in depressions in the till surface. These tend to be concentrated along the edges of the major stream valleys. No doubt the earliest postglacial drainage of the area consisted of series of ponds joined by short lengths of streams which gradually cut headward to drain the ponds and erode valleys.

Abandoned Shorelines

As remarked above, none of the higher-level lakes left recognizable shorelines in the area; the highest and most prominent shoreline is that of Lake Iroquois. The position of the Lake Iroquois shoreline in this report-area is shown on the accompanying geological map. No surveys were conducted on the elevation of this shoreline because it was considered that nothing significant could be added to the previous studies by Coleman (1937) and Wilkinson (1959). However, a general summary will be given of the features in this area.

The Iroquois shoreline serves as a boundary, extending from southwest to northeast across the area, between till plain to the north, and lake plain to the south. As noted long ago by Spencer (1889), the shoreline is tilted up to the northeast. In the southwest part of the area, the shoreline has an elevation of about 440 feet above sea level; near Guildwood Village it is about 450 feet, and near Cherrywood to the northeast, about 470 feet above sea level. This is an average rise of 2.5 feet per mile, which compares favourably with Wilkinson's determinations (1959) of 2.1 feet per mile at Hamilton and Toronto, and 3.1 feet per mile at Oshawa; he determined the direction of maximum tilt to be N21°E at Toronto.

Tracing the shoreline from southwest to northeast, it enters the area at the intersection of Dawes Road and Victoria Park Avenue, forming a cliff about 30 feet high which is interrupted briefly by the valley of Massey Creek. Near Danforth Avenue, it lowers in height and blends with the crest of the large sand and gravel bar which extends to the west to the Don River. This bar was constructed as a spit by the currents of Lake Iroquois carrying sediment westward from the high bluffs to the east. The position of the bar deflected the early Don River drainage westward; if it had not been for this, the Don would likely reach Lake Ontario near Woodbine Avenue. The formation of this spit is quite comparable to the formation of the modern spit in Lake Ontario known as Toronto Island.

Where the Iroquois bluff reaches Danforth Avenue, it swings abruptly eastward, becoming a prominent feature again as it approaches Kingston Road, there again forming a cliff 30 feet high. East of Kingston Road, it gradually increases in height to about 50 feet near Chine Drive; gulleys interrupt this section of the old bluff every 500 yards or so. The names of some of the streets in this district are obviously derived from the presence of the Lake Iroquois bluff, Cliffcrest Crescent and Undercliff Drive being at the top and base of the bluff respectively. At the Seminary, a cross-section through the bluff is well exposed by a prominent gulley, thus providing a favourite spot for visiting geologists to view the sequence of glacial deposits (see Photo 3). East of the Seminary gulley, the bluff continues for about 3/10 of a mile and then merges with the present Bluffs eroded by Lake Ontario; for about one mile the old bluff is missing where recent erosion has removed it.

When the bluff again appears at Cudia Park, it is about 130 feet high; not far to the east, at the foot of Markham Road, it reaches its maximum height of 150 feet. Farther along, it gradually swings more to the north and decreases in height to 40 feet or less as it approaches Highland Creek near Guildwood Village.

North of Kingston Road, the bluff is not evident for some distance; instead, a low gravel bar, with interruptions at the valleys of Highland Creek and Rouge River, takes its place. The profile of the bar is well shown along Sheppard Avenue east of Morningside Drive. To the west of the bar a narrow lagoon formed in front of a gentle bluff; along this depression, Highland Creek was diverted northwards.

North of Rouge River and west of Meadowvale Road the first of a series of small embayments in the shoreline appears. The embayments were originally low areas between drumlin ridges which projected into Lake Iroquois; gradual erosion of the headlands developed cliffs on their ends, and the resulting sediment was deposited as gravel bars across the mouths of the bays. One mile south of Cherrywood, a continuous bluff again may be seen, varying from 40 to 50 feet in height. This bluff continues for nearly 2 miles to the northeast, where it is cut away by Duffin Creek and leaves the area.

None of the several shorelines located by Mirynech (1962) below the Iroquois shoreline in the Trenton district have been identified in this area. Mirynech's "Belleville Stage", the most prominent of his lower beaches, lies about 300 feet below the Iroquois beach. Because the old shorelines slope down to the southwest, they could be submerged by Lake Ontario in the Toronto area. It is interesting to note that McCrindle (1961), in a study of lake-bottom features offshore from the Toronto Hunt Club, indicates the presence of a low cliff about 2,500 feet from the shore; the top of the cliff is about 30 feet and the base about 40 feet below the lake surface. Mineralogical studies showed considerable similarity between the sediments at the base of the small cliff and the present beach sediments. Perhaps this is an old submerged shoreline which might correlate with one of the post-Iroquois beaches. Since it is about 230 feet below the Iroquois shoreline, it may relate to one of Mirynech's lower beaches. More studies of the lake bottom may reveal the presence of these beaches.

Stream Terraces

Several of the streams in the area are mature enough to have developed small flood plains. But only the largest streams — Duffin Creek, Little Rouge Creek, Rouge River, and Highland Creek — have developed terraces along their valleys.

It is to be expected that streams well-developed at the time of Lake Iroquois would have high-level terraces corresponding to the level of Lake Iroquois. But only the west branch of Duffin Creek possesses a terrace of possibly the right level. That comparable terraces did not develop on other streams appears to be due to the presence of higher land near Duffin Creek. Elevations along the Rouge valley were not sufficiently higher than Lake Iroquois to allow terrace development; and, at the time of Lake Iroquois, Highland Creek was too small, as well as the surrounding land being too low, to allow terracing to occur.

High-level terraces on Rouge River and also those developed to a lesser extent on Little Rouge Creek are below the Iroquois level. A prominent terrace in the vicinity of Sewell's Road and Finch Avenue is about 40 feet above present river level. Several lower terraces are present on Duffin Creek, Little Rouge Creek, Rouge River, and Highland Creek. The terraces on Highland Creek are mostly rather young, as indicated by the fact they are not far above present stream level; this is in keeping with the generally youthful development of the stream valley.

The modern flood plain of these major streams is in part well-developed, particularly along the valleys within 1 or 2 miles of Lake Ontario, the present base level of erosion. In these portions of the valleys, older terraces are being drowned and buried by younger alluvium because of gradual rise in lake level (believed caused by

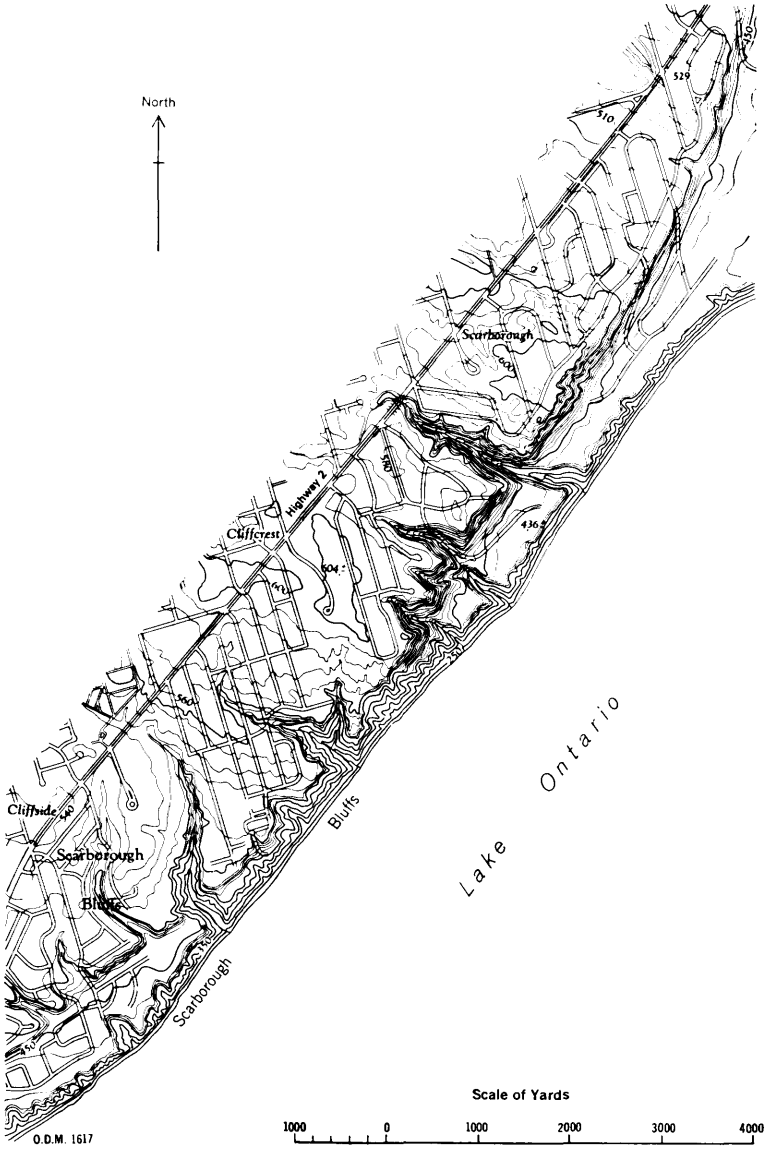

Figure 4—Alluvial fans on the Lake Iroquois terrace.

rebound of the land after the retreat of glaciers). A middle section of the Rouge drainage has only a narrow flood plain bordered by older terraces; more than about 5 miles from Lake Ontario, flood plains again widen out. Detailed surveys on the terraces of these valleys would no doubt elucidate their sequence and origin.

Alluvial Fans

In the central part of the bluffs, between Midland Avenue and Guildwood Parkway, where the Iroquois bluff has its greatest height, there are several small alluvial fans built on the Iroquois terrace. These fans were deposited by small streams that cut gulleys into the Lake Iroquois bluff during and after Lake Iroquois had disappeared. It is probable that the sediment transported by the streams into Lake Iroquois was carried away by currents along the shore, leaving little or no accumulation at the stream mouth. After the lake receded, however, the sediment accumulated at the foot of the steep slope. The process at work here is the same as that which produces the huge piedmont alluvial deposits at the base of the mountains in the arid regions of the southwestern United States; the streams erode rapidly as they tumble down their steep gradients but when they reach the flat plain their ability to transport sediment suddenly is decreased and most of the load is dropped at the sharp change in slope. The result is that low cones, or fans, of stream sediment are formed. Caution should be used in measuring elevations on the old shoreline near gulleys in the shorecliff, as spuriously high values may be obtained on top of alluvial fans.

Examples of these features can be seen in Figure 4, which shows the form of these fans in the shape of the contours. In many cases the streams which formed the fans have recently cut gulleys down into the Iroquois terrace, revealing cross-sections through the sediments as the modern Bluffs have been eroded back close to the Iroquois bluff.

Swamps and Bogs

Many of the depressions in the till plain surface, and some of the stream terraces, have been more or less completely filled in by organic accumulations. Accumulations of marl, muck, and peat have developed where there is poor drainage. In many cases the swamps succeed a pond or lake stage. Such occurrences are widely scattered throughout the area. The organic accumulations are usually shallow — i.e. less than 10 feet thick.

Stratigraphy

General. The sequence of glacial deposits in the report-area has long attracted attention, that in the Bluffs having few rivals in North America. Only in deep exposures along the river valleys and in the lake bluffs can one see under the deposits of the latest ice sheet, and back into geologic time more than a few thousand years. The record of the oldest beds in Scarborough stretches back to the last interglacial stage, when the climate around the Toronto region was warmer than present, and even to the second-last glaciation, perhaps 100,000 or 150,000 years ago.

Most of the previous stratigraphic studies in the area have been concentrated on the excellent exposures in the Bluffs. Only Coleman (1933) seems to have noted any of the numerous cuts along the stream valleys of the area, and his study was apparently only of a reconnaissance nature. Therefore, this report is the first detailed account of the river-valley stratigraphy. Correlation between the river sections and the Bluffs has been generally established and indicates the presence in the area of six separate till sheets, four of which appear in the Bluffs, and a different four of which have been found along the valleys. Comparison of the valley and Bluffs exposures provides a three-dimensional impression of the distribution of the various stratigraphic units.

Detailed descriptions of individual sections in the Bluffs and river valleys can be found in Appendix A of this report; the sections are illustrated on Chart B (Figures 5 to 13) and their locations are given in Appendix C and on Chart A. (Charts A and B are in back pocket.)

Scarborough Bluffs

The Scarborough Bluffs are the modern shorecliffs of Lake Ontario, and extend nearly the full width of the area along the lakefront from Victoria Park Avenue, at the west edge of Scarborough township, to the mouth of Highland Creek, 9 miles to the northeast. Through most of the distance, from half to four-fifths of the height of the Bluffs is made up of deposits, named the "Scarborough Formation", formed in an ancient delta; these deposits are quite fossiliferous, plant remains being the most obvious. On top of the deltaic beds are layers of glacial till, four in number and separated by beds of stratified clay and sand, all believed to represent the deposits of the last, or Wisconsinan, stage of glaciation.

At three places the overlying till thickens to partially or completely fill depressions in the top of the Scarborough beds. In two of these, located just east of the foot of Midland Avenue and west of Beechgrove Drive, the till extends to below the present lake level; they are believed to have originated as stream valleys cut into the ancient delta during an interval of low-water levels. The third valley, located west of the Guild Inn, is much shallower and may only represent a distributary channel of the stream that built the large delta. At all three places, where the till thickens, a promontory has developed in the shore; this is because of the hardness and massiveness of the till, which better resists the effects of erosion.

Exposures are outstanding in the Bluffs; it is usually possible to get a fairly clean section within a short distance of any arbitrarily selected point. Thus, in this study, over 30 measured sections were recorded along the Bluffs, representing an average of nearly one section every quarter mile, or nearly the ideal for the scale of mapping in this report. In the central and higher part of the Bluffs, several of the sections were taken in the gulleys tributary to the Bluffs, where access is easier (see Photo 4 on p. 14, 15).

Because of the excellent exposures, and because several of the units are exposed only here, the Bluffs constitute the type section for several stratigraphic units of the Pleistocene sequence.

Massey Creek Sections

A number of good exposures are to be found along the portion of Massey Creek that flows through the southwestern part of the area. Most of these are to be found south of St. Clair Avenue East and west of Warden Avenue (see Fig. 6, Chart B).

The sequence exposed on Massey Creek is: an upper complex of sandy tills and sand beds, probably representing the two youngest tills of the area, overlying a series of lacustrine sands and varved clays, overlying the earliest Wisconsinan till (having a silty or clayey texture), which in turn overlies a few feet of peaty clay identified as the Scarborough Formation. As in all the other stream valleys, the youngest units are to be found to the north where the valley is shallower, and the oldest units are to be found farther south where the stream bed reaches lower elevations.

Highland Creek Sections

Highland Creek has numerous sections along both of its branches, but the west branch has the better exposures.

The main group of sections on the west branch (Fig. 7, Chart B) begins east of Markham Road and extends north of Lawrence Avenue to where it joins the other branch. The general sequence exposed begins at the top with the latest Wisconsinan sandy till, stratified sands, a fine-textured till, an older clay till (early Wisconsinan), and stratified sands and clays of the Scarborough Formation. The top of the Scarborough sands, as in the Bluffs' exposures and elsewhere, has an elevation of 400 feet.

The east-branch sections (Fig. 8, Chart B), being less well exposed, are somewhat more difficult to correlate. But, the major difference is that the stream bed is not as deeply cut down so only in the lower portion of the valley above the junction with the west branch are exposed the earliest Wisconsinan till and Scarborough Formation. Upstream, a clay till and the late-Wisconsinan sandy till are exposed.

Below the junction of the two branches (Fig. 9, Chart B), and west of Morningside Avenue, several sections reveal Scarborough sands and overlying clay tills of uncertain affinities. Then for more than half a mile, there are no significant exposures. However, south of Highway 2 bridge, in Lower Highland Creek Park, several sections reveal a sandy till overlying a clay till, probably the latest and earliest Wisconsinan tills respectively.

Rouge River Sections

The Rouge River is probably the best endowed with sections of any of the streams that cross the area (Fig. 10, Chart B). The units which have been identified along its banks are the two late-Wisconsinan sandy tills, early Wisconsinan clay till, Scarborough beds, Illinoian till, and Ordovician shale bedrock. In addition, there are several occurrences of till whose correlation is problematical, and also numerous sand and clay units with no apparent continuity.

Scarborough sands occur upstream as far as Finch Avenue, and the overlying clay till may be seen in the river bed and lower part of the banks as far up as the C.P.R. bridge (Oshawa line). Downstream, bedrock appears underlying Scarborough beds at the base of various sections from ⅓ mile north of Twyn Rivers Drive to Highway 401. In the last section north of Highway 401, a few feet of Illinoian shaly till lie between the Scarborough beds and the shale bedrock.

A few sections occur along a tributary to the Rouge River (Fig. 11, Chart B) east of Littles Road and north of Sheppard Avenue. They expose late-Wisconsinan sandy till in the upstream sections and early-Wisconsinan clay till and Scarborough beds in the downstream sections.

Little Rouge Creek Sections

Sections along Little Rouge Creek (Fig. 12, Chart B) are comparable in sequence to those along the Rouge River. The two streams join about ¼ mile north of Highway 401.

The late-Wisconsinan sandy till is exposed in most of the sections. Early-Wisconsinan clay till occurs in exposures for an interval of about one mile south of

Finch Avenue; south of that point, Scarborough beds directly underlie the sandy till. Bedrock (shale) occurs in several sections between Twyn Rivers Drive and its confluence with the Rouge River.

West Duffin Creek Sections

Of all the streams in the area, West Duffin Creek has the most internally consistent sequence of deposits; correlation between sections in this valley is easy (Fig. 13, Chart B). The sequence consists of late-Wisconsinan sandy till over a thick sequence of stratified fine sand which grades downwards into stratified silt and clay. At the base the clays are contorted and grade into clay till, thought to be the early-Wisconsinan till. Coleman (1932) thought the sands and clays were part of the Scarborough beds, but no organic remains were found in them during this study so they are considered to be of interstadial age.

Formations and Events
(Formal names of formations are in bold face)

Stage		Formation or Event	Lithology
Recent		Lake Ontario beaches. Alluvium. Swamp and bog deposits. Stream terrace deposits.	Beach, sand, gravel. Clay, silt, sand, gravel. Marl, muck, peat. Clay, sand, gravel.
Wisconsinan	Late	Lake Iroquois. Early peripheral lakes. **Leaside Till.** Lake and stream deposits. **Meadowcliffe Till.** Lake and stream deposits. **Seminary Till.**	Clay, sand, gravel. Clay, sand. Silty sand till. Varved clay, sand. Silty clay till. Varved clay, sand. Clayey sand till.
	Middle	**Thorncliffe Formation.**	Varved clay, sand.
	Early	**Sunnybrook Till.** **Scarborough Formation.**	Silty clay till. Clay, silt, sand, wood.
Sangamonian		**Don Formation.**	Clay, sand, wood.
Illinoian		**York Till.**	Clayey sand till.

York Till

Terasmae (1960) applied the name "York Till" to the thin till layer occurring between bedrock and the interglacial Don beds in the Don Valley brickyard. Similar till has been found in a comparable stratigraphic position along the Rouge River about a quarter of a mile north of Highway 401 (section F251).

In this exposure the till consists of 6 feet of buff clayey sand till, with many shale fragments, resting on bedrock and overlain by several feet of peaty sand and clay classified as Scarborough Formation. Determination of the orientation of pebbles in the till indicates ice movement from the northeast. Mechanical analysis gives a composition of 30 percent clay, 23 percent silt, and 47 percent sand. Pebbles in the till were found to be 22 percent limestone, 75 percent shale, and 3 percent Precambrian rock. Carbonate analysis of the till matrix (Dreimanis 1962) yielded 22 percent calcite, 6 percent dolomite, and a calcite-dolomite ratio of 3.7.

The identification of the till in section F251 as York Till depends on its occurrence below the Scarborough Formation and the similarity of its lithology to that of the type section in the Don brickyard. Table 3 compares analytical results for the Don brickyard as reported by Watt (1955), Dreimanis and Teresmae (1958), Ostry (1962), and the author. These results are compared with the author's F251 and also an F251 sample analyzed by Ostry.

Table 3 *Analyses of York Till*

	SAND percent	SILT percent	CLAY percent	CALCITE percent	DOLOMITE percent	CALCITE/DOLOMITE RATIO
DON BRICKYARD						
Watt	52	19	29			
Dreimanis and Terasmae	51	20	29	13	9	1.4
Ostry	50	24	26	9	5	2.3
Karrow	48	22	30	13	5	2.6
SECTION F251						
Ostry	60	21	19	23	6	3.8
Karrow	47	23	30	22	6	3.7

Another exposure, which may be of the York Till, is located ½ mile south of the previous one on the Rouge River (F169). There is evidence of considerable disturbance in the section so that the lower part of the sequence is not clearly exposed. The lowermost 5 feet of the section above the river level is a shaly till containing a sedimentary dike filled with coarse sand striking 110°. The till mass appears to have slumped and rotated, thus invalidating the pronounced fabric which was found to be from the north-northeast. Analysis yielded 17 percent clay, 12 percent silt, and 71 percent sand; the matrix was 1 percent calcite, 3 percent dolomite, and had a calcite-dolomite ratio of 0.3. The sequence in the section suggests that the till is at least as old as Early Wisconsinan, but it could be Illinoian, or even older. The atypical carbonate content may be due to leaching of carbonates by weathering or may indicate affinities with the Sunnybrook Till, some of which has similar carbonate composition.

The assignment of the York Till to the Illinoian glacial stage is the most reasonable at this time. General rarity of exposure makes study of this unit difficult. Till of the same age has been reported in subway excavations in Toronto (Watt 1954; Lajtai 1961) and has been encountered in other deep excavations in downtown Toronto.

Toronto Group

The term Scarborough beds was adopted by Coleman (1909) in referring to the fossiliferous clay and sand so prominently exposed in the lower half of the Scarborough Bluffs. At the same time, he designated fossiliferous sand and clay exposed along the Don River valley as Don beds. The sediments constituting these units had earlier been included in the Toronto formation by Chamberlin (1895). It now seems more appropriate to raise the rank of these units. Therefore, the Toronto Group is here considered to consist of two units, the Don Formation and the Scarborough Formation.

Don Formation

The Don Formation has not been identified in any exposure in the Scarborough area but has been encountered under the Scarborough Formation, below the level of Lake Ontario, along the Bluffs. Information from wells at the Bluffs and from exposures to the west in Toronto indicates a thickness of about 25 feet. More complete descriptions of this unit and its abundant animal and plant fossils may be found in Coleman (1932) and Terasmae (1960).

Scarborough Formation

At the type section in the Bluffs, the Scarborough Formation consists of a lower clay unit averaging 90 feet of exposure above the present lake level and an upper sand unit averaging 50 feet in thickness. The sinking of wells and auger holes along the beach at the base of the Bluffs has revealed, overlying sand and clay of the Don Formation, 10 to 15 feet of the lower clay unit below lake level. While a gradual transition occurs from the clay below to the sand above, it was found that a fairly consistent boundary could be placed at the level where springs issued. Below this level the beds were generally dark grey and moist; above it, buff and dry.

Going inland, the Scarborough Formation has been identified along most of the major streams. It is found in the base of the southernmost section on Massey Creek, along Highland Creek from east of Scarborough Golf Club Road to west of Kingston Road, along Rouge River from Finch Avenue to Kingston Road, and along Little Rouge Creek from west of Twyn Rivers Drive to Kingston Road. It is the lowest unit exposed in almost all of these sections. Coleman regarded the stratified silts along Duffin Creek as belonging to the Scarborough beds; but various considerations — lack of plant fragments, different lithology, higher elevation, and their stratigraphic position — indicate them to be younger deposits of glaciolacustrine character.

In detail, the lithology of the beds includes a wide variety of sediment types. The clay member varies from rhythmically-bedded, stratified clay and silt to massive sandy silt beds several feet thick, and to irregularly-bedded silt and sand. Disseminated fine plant detritus is everywhere present and occasionally larger pieces of wood a few inches in length may be found. Coarser fragments are found more frequently near the top of the clay where coarser sediment is present; thin layers of compressed plant remains are not uncommon. The clays are dark grey in color when wet, but dry to a light creamy grey, having a somewhat brownish appearance when compared to glacial varved clays, which appear almost blue-grey in comparison. Carbonate content is another point of contrast: the Scarborough clays having a much lower carbonate content than the varved clays. Nevertheless, Scarborough clays and varved clays are frequently confused.

The sand member varies from fine to coarse sand, and is interbedded with silt toward the base. Stratification is well-developed, with numerous red and black laminae composed of concentrations of garnet and magnetite. The sands tend to

Photo 5—Crossbedding in sands of the Scarborough Formation indicating southward-flowing stream. Section A1015 near Meadowcliffe Drive.

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appear at times slightly orange in colour, at other times slightly pink or salmon, usually showing a subtle contrast to the buff or grey-buff of other sands. Crossbedding is common in the sands and foreset beds consistently slope to the south (see Photo 5). Whorls and contortions in the beds may be attributed to underwater slumping during sedimentation. Terasmae illustrated well some of the sedimentary features of the Scarborough Formation (1960, Plates V and VI).

Concretions occur in both the sand and clay members, but are so distinctively different that they can be distinguished one from the other when they occur in the Lake Ontario beach gravels along the base of the Bluffs. Those from the clays are cream in colour with a smooth exterior and platy shape; those from the sand are yellow to brown in colour, have sand adhering to their exterior, and are more ovoid in shape. The former appear to have a limy composition; the latter are high in iron oxide. Ure (1950) has studied similar concretions in North Toronto.

Plant fragments are abundant in the sand, occurring as peaty concentrations in the bedding planes, or as pieces of wood a foot or more in length. Such plant detritus, seems more abundant in the lower part of the sand, but has been seen near the top as well. In several places, the wood was seen to be mouldy and rotten, even a considerable distance in from the exposed face. A sample of wood from the middle part of the sands, collected in the summer of 1959 by the late H. de Vries and the author, was dated as over 52,000 years in age (Gro-2555; H. de Vries, letter of 10 October 1959); this is the oldest date yet run on either the Don or Scarborough formations (Scarborough L-522B>40,000 years; Don: L-409>46,000 years). Another sample from the Scarborough sand, collected in 1961, is being dated at the Groningen Laboratory by isotope enrichment, but results are not yet available.

The plants so far identified from the Scarborough Formation, as reported by Coleman (1932, 1941) and Terasmae (1960) are:

COLEMAN

Alnus sp.	*Chenopodium* sp.
Carex aquatilis	*Brasenia purpurea*
C. utriculata	*Prunus* sp.
Picea sp.	*Polygonum* sp.
Salix sp.	*Ceratophyllum demersum*
Equisetum	*Larix americana*
Vaccinium oxycoccus	*Abies balsamea*
V. uliginosum	*Hygrohypnum palustre?*
Scirpus fluviatilis	*Drepanocladus vernicosus*
Potamogeton sp.	*Hylocomium*

TERASMAE

Abies sp.	*Larix* sp.
Acer sp.	*Picea glauca*
Betula sp.	*P. mariana*
Castanea sp.	*Pinus banksiana*
Carpinus sp.	*P. strobus*
Carya sp.	*Quercus* sp.
Corylus sp.	*Shepherdia* sp.
Fagus sp.	*Tilia* sp.
Fraxinus sp.	*Tsuga canadensis*
Ilex sp.	*Ulmus* sp.
Ambrosia sp.	*Myrica* sp.
Artemisia sp.	*Myriophyllum* sp.
Caryophyllaceae	*Nuphar* sp.
Chenopodiaceae	*Nymphaea* sp.
Ericaceae	*Rubus chamaemorus*
Gramineae	*Sparganium* sp.
Menyanthes sp.	*Typha latifolia*

Polypodiaceae
Osmunda sp.

Sphagnum spores

Lycopodium annotinum
Lycopodium sp.
Selaginella sp.
Fungus spores

A much earlier list of species by Hinde (1877) also included the following:

DIATOMACEAE
Navicula
Stauroneis
Pinnularia

ALGAE
Chara sp.

MUSEI
Bryum
Fontinalis
Hypnum commutatum
H. revolvens?
Hypnum sp.

LYCOPODIACEAE
spores?

Several samples of sediment from an exposure of presumed Scarborough Formation were submitted to J. Terasmae of the Geological Survey of Canada for examination of the pollen and spore content. The details of each of these samples and those from other localities and stratigraphic positions are given in Appendix B at the end of this report. The locality in question here is F251, already referred to in the description of the York Till. On the basis of the pollen study, the beds containing plant remains overlying the shaly till were considered to be part of the lower member of the Scarborough Formation.

The Scarborough Formation is also noted for its animal remains. A number of species of molluscs have been identified from the sandy part of the beds where they occur either scattered through the sand or in the peaty layers; in the latter case they are usually crushed to fragments. Shells are far from abundant and seem to have an irregular pattern of distribution in sparse concentrations. Coleman (1933) lists the following:

Sphaerium rhomboideum
S. Fabale
Valvata tricarinata
Limnaea sp.
Planorbis sp.

Additional samples were collected by the author and were submitted to J. Oughton, Ontario Agricultural College, who identified the gastropods; pelecypods were identified by H. B. Herrington:

GASTROPODA
Succinea sp.
Physa sp.
Valvata tricarinata Say

PELECYPODA
Spaerium striatinum (Lamarck)
Sphaerium sp.

Referring particularly to the Don Formation, Baker (1931) made remarks which can be applied to the Scarborough Formation as well when he said: "It is apparent that more intensive collecting in the Toronto deposits is urgently needed. The clays should yield a large number of the small gastropods and pelecypods. A large quantity of material from the Don beds should be collected and studied in the light of recent molluscan classification." More than 30 years later, this still has not been done, and, with advancing urbanization, the need is more urgent than ever.

The most amazing biotic remains found in the Scarborough beds are those of insects. First mentioned by Hinde (1877), and later studied by S. H. Scudder, they were reported by Coleman (1941) to include 9 genera and 34 species of Carabidae, 3 genera and 8 species of Dysticidae, 1 species of Gyrinidae, 1 species of Hydrophilidae, 11 genera and 19 species of Staphylinidae, 1 genus and 2 species of Chrysomelidae, 4 genera and 6 species of Curculionidae, and 1 species of Scolytidae. The insect remains are said to be concentrated in the peaty beds. Of the long list of insects, only two are apparently still living. Like Terasmae (1960, p. 37), this author would like to see a new intensive study of these remains, as there is no doubt much new information to be gained, taking into consideration more recent entomological knowledge.

Samples of the Scarborough beds, examined by D. G. Frey, revealed the presence of well-preserved remains of Cladocera (Frey 1961) although no extensive study has been undertaken.

Hinde (1877) reported the presence of two or three species of *Cypris* (ostracods) although several samples submitted to E. M. Winkler, Notre Dame University, failed to reveal additional specimens (samples from the Don Formation did yield specimens however). It is anticipated that further studies on this group will be undertaken. (Diatom studies have recently been undertaken for both the Don and Scarborough formations.)

From the foregoing, it can be seen that the Scarborough Formation is very fossiliferous. The plants indicate a cool climate with an annual mean temperature about 10° Fahrenheit cooler than present (Terasmae 1960, p. 38). Molluscs are mostly of species that live in shallow water in the northern half of the continent. Many of the molluscs are found in large lakes.

The lithology of the beds supports the theory of deposition in a delta which formed at the mouth of a large river on the north side of the Ontario basin when the water level was more than 150 feet higher than present, that is, about the same level as Lake Iroquois; drainage of the lake through the Hudson Valley is a possibility. This lake has been named Lake Scarborough[1] by Coleman (1941). The top of the sequence is consistently between 350 and 400 feet above sea level, even to the west along the Don River (Watt 1955), and in borings at Davisville Avenue and Yonge Street in Toronto. It would be expected that a large lake would have other deltas around its periphery, but none have as yet been found, so they must be deeply buried or were destroyed by later erosion. It would be very easy to confuse later deposits with the Scarborough Formation if lithology were similar, but if enough plant material were obtained, they could probably be distinguished by radiocarbon dating.

The top of the Scarborough Formation has been eroded by at least three former streams along the length of the Bluffs exposures. The most publicized formation is that at the "Dutch Church", a landmark formerly more prominent than today, where the overlying glacial till partly fills a valley which extends nearly 20 feet below present lake level. The vagaries of erosion in past decades had sculptured a tower-shaped mass of the thick till layer in the valley giving rise to the name Dutch Church; at present a much-wasted remanent stands at the foot of Scarboro Crescent to mark the former position of the ancient stream. The next valley to the east is much more shallow, not even completely cutting through the sand member. It is located in the vicinity of Livingston Road, west of the Guild Inn. The third and broadest valley is west of Beechgrove Drive; its width is half again as great as that of the Dutch Church and its depth below the lake may well be greater. This valley appears to differ from the other two in being filled by a much younger till; this may indicate a considerably younger valley. The only occurrences of gravel associated with the Scarborough Formation are to be found in and near these valleys. They may represent small remanents of deposits laid down by the

[1]Editor's Note: In 1878, G. J. Hinde used the spelling Scarboro' for both geological and geographic names, probably as an abbreviation for the correct and legal spelling Scarborough. Coleman's "The last million years", published posthumously in 1941, followed the same style but omitted the apostrophe even in quoting the Hinde work. A. P. Coleman's work, during his lifetime when published and indexed by Ontario Dept. Mines, used the spelling Scarborough (in full) for both geological and geographical names, and this is the accepted Departmental usage.

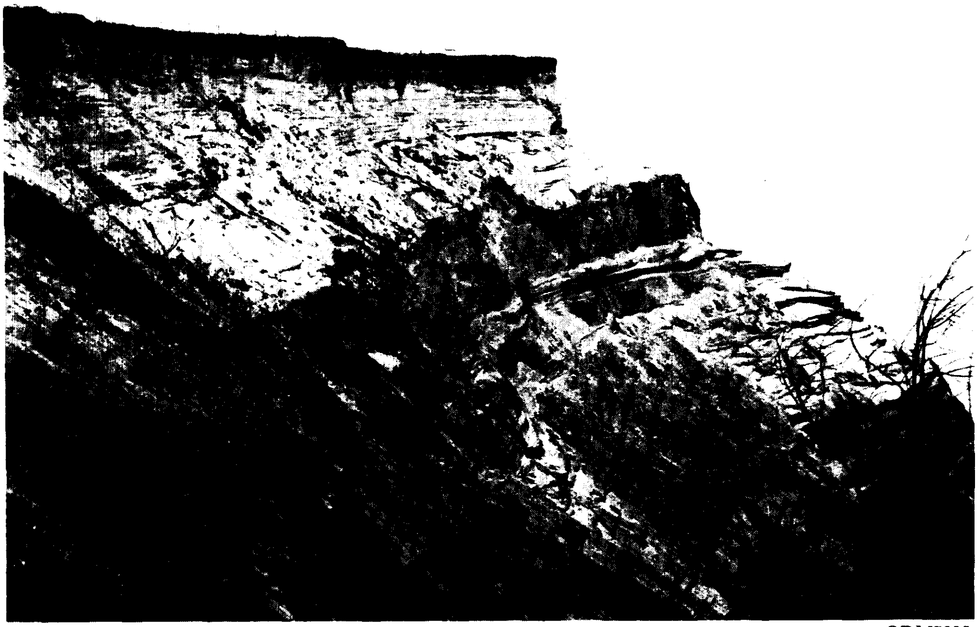

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Photo 6—Section at Cudia Park (A1014) showing, from top down: alluvial silts, Lake Iroquois silts, Thorncliffe Formation sand, Sunnybrook Till, and Scarborough Formation.

streams eroding the valleys. In the Dutch Church valley, the overlying till contains lenticular inclusions of these gravels several feet in diameter. At Livingston Road, channel structures have created small unconformities in the bedding.

To the northeast of the area, there appears to be another valley cut in the Scarborough Formation near Port Union and extending to near Rosebank Station; such a broad depression may indicate a major stream course, possibly reflecting bedrock topography. As noted by Coleman (1932), Scarborough clay appears intermittently between Rosebank Station and Frenchman Bay, usually capped by till.

From the extent of the beds, it may be seen that they form a broad arch, being the backbone of the southerly projecting highland of Scarborough Township. This large mass of sediment, probably located at the mouth of a major bedrock depression, has pretty well obliterated the bedrock topography in the area. All subsequent deposits appear as thin sheets draped over the arch of the Scarborough Formation.

Sunnybrook Till

Terasmae (1960, p. 27) applied the name Sunnybrook Till to the lowest sheet of till overlying the Scarborough Formation. It forms vertical cliffs in the Bluffs (see photos 3 and 6), where it is exposed extensively; it also occurs along the major streams inland. It is exposed on Massey Creek just west of Warden Avenue, Highland Creek from just east of Scarborough Golf Club Road to the junction of the two main branches and again south of Kingston Road, Rouge River from west of Sewell's Road to west of Kirkham's Road and again from Twyn Rivers Drive to Kingston Road, Little Rouge Creek from Finch Avenue to Beare Road, and on West Duffin Creek near Clarkes Hollow. The missing intervals on Highland Creek and Rouge River are

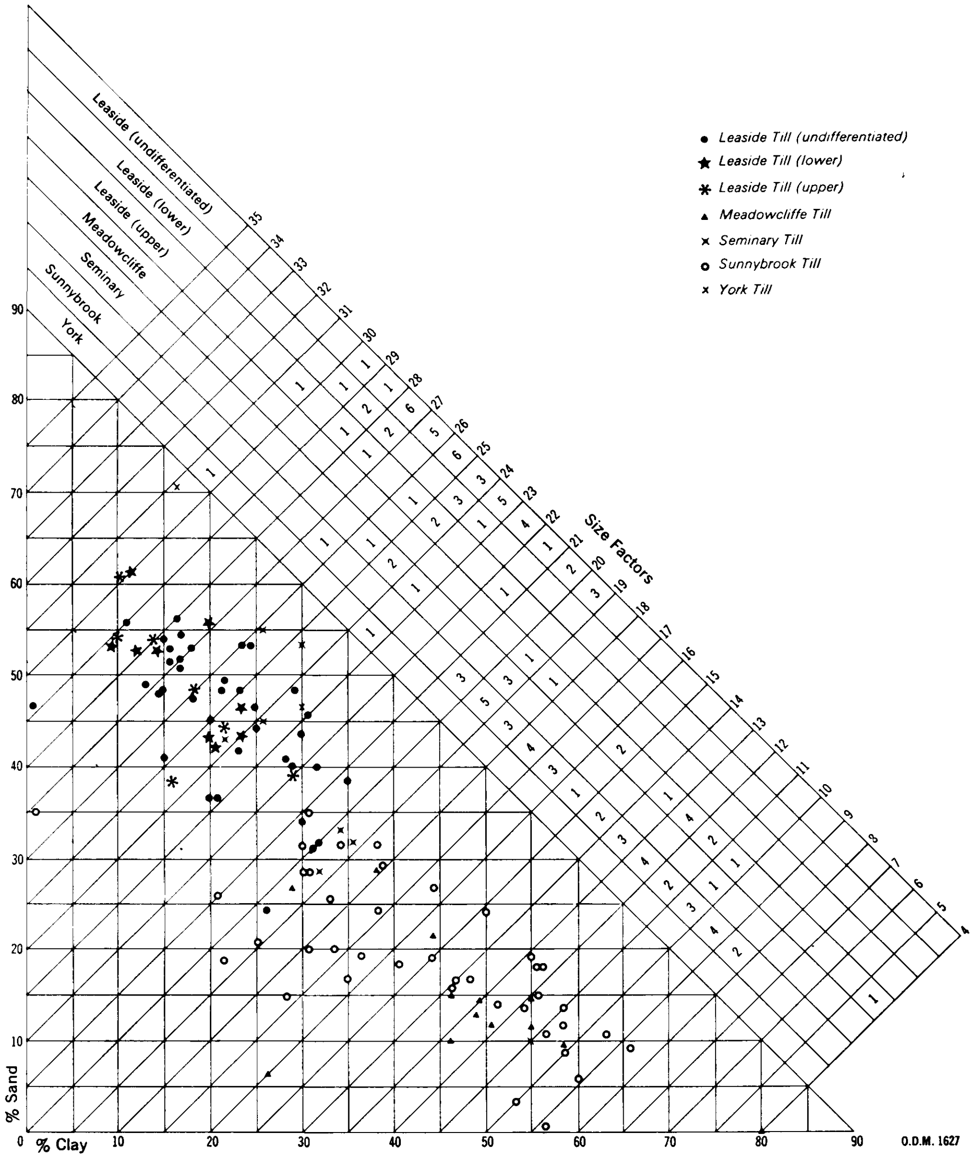

Figure 14—Size analyses of tills in the Scarborough area.

interpreted as having resulted from later erosion, as will be discussed later (p. 48). Its stratigraphic position immediately over the Scarborough Formation largely controls its occurrence; it conforms to the shape of the top of the Scarborough sand and can usually be found at about an elevation of 400 feet above sea level. The exceptions, where it occurs in valleys in the underlying beds, have already been noted.

The thickness of the till varies considerably, but it is most often about 20 to 30 feet thick in the Bluffs, 30 feet on Massey Creek, 10 to 20 feet thick on the upper part of Highland Creek, and 20 to 30 feet on the Rouge River. Greater thicknesses occur where the till partly or completely fills an older valley in underlying beds, such as at the Dutch Church, where it thickens to about 90 feet, Livingston Road 60 to 75 feet, and lower Highland Creek 40 to 100 feet. Other irregular thickening and thinning occurs which is most likely due to uneven deposition by the ice.

In texture, this is a fine-grained till, varying from a silt till to a silty clay till with low pebble content. Analyses on 29 samples selected for certain identification as Sunnybrook Till yielded average values of 45 percent clay, 37 percent silt, and 18 percent sand. Detailed results of till analyses are given in Table I in Appendix D. A diagram comparing results of mechanical analyses of the various tills is shown in Figure 14.

Carbonate analyses on 22 selected samples of till matrix averaged calcite 6 percent, dolomite 6.5 percent, and calcite-to-dolomite ratio of 0.9. Pebble counts on 10 samples yielded average compositions of 45 percent limestone, 12 percent dolomite, 26 percent shale, and 17 percent Precambrian. Sandstone, similar to the Potsdam Formation of eastern Ontario, was often present in variable amounts.

Measurement of pebble orientations, including a vertical series of eight horizons at 5-foot intervals in thick till at Livingston Road, indicated variation in direction of ice movement from slightly west of south, to west, to northwest, no doubt reflecting increasing and decreasing effect of local topography as the ice sheet thickened and thinned.

The extensive exposure of the Sunnybrook Till in the Bluffs provides an unusual opportunity to study variations in composition with lateral extent and changes in underlying materials. Even the sparse information at hand illustrates this point (see Fig. 15) and suggests that considerable caution must be used in considering analytical results without relating them to the circumstances found in the field. A few specific points may be brought out from Figure 15. It can be seen that dolomite content in the matrix is fairly constant while calcite fluctuates; this suggests a more distant source for the dolomite than for the calcite, allowing a more thorough mixing of dolomite. The situation is more involved when pebble sizes are considered; in this case, shale is the greatest variable, distorting the proportions of the other components. Since shale is the local bedrock, it is not surprising that it is present in the pebbles and that it varies in percentage. Dolomite and Precambrian pebbles seem to follow similar trends of variation, at times similar to, and at other times dissimilar to trends in limestone.

Contamination from the underlying Scarborough Formation could explain, at least to a considerable extent, the low carbonate ratio in this till; but could not explain the presence of so many dolomite pebbles. This low ratio, together with garnet composition, has led Dreimanis and Terasmae (1958) to conclude that the ice which deposited this till passed over eastern Ontario where Beekmantown dolomite is exposed. Their theory is supported by the results of the present study.

Sunnybrook Till, or till of the same age, has been found in many downtown Toronto excavations; including both the University and Yonge subways (Lajtai 1961; Watt 1954). Dreimanis and Terasmae correlated an old till referred to by Watt (1955) in North York Township with the same unit, not at that time named, which they considered to be of Early Wisconsinan age. At present, the age of this till must remain as inferred by Dreimanis and Terasmae. Its known extent establishes it as a major till sheet in the Toronto area, extending under most of the Metropolitan Toronto area, including Scarborough.

Thorncliffe Formation

Between the earliest Wisconsinan Till, the Sunnybrook, and the latest till, the Leaside, there exists a variety of glacial, fluvial, and lacustrine deposits which appear to have a complex distribution and most often cannot be traced for any considerable distance. Coleman (1909) regarded these as interglacial deposits, and, correlating them with similar beds described by Wilson (1905) east of Toronto, named them the deposits of the Clarke Interglacial Period (after Clarke township); since the age of the tills and sands at Newcastle, in Clarke township, has still to be determined, and no correlation between there and Scarborough has been established, the term Clarke cannot be applied in Scarborough. Terasmae (1960, p. 27, 29) divided these sediments into two parts: a lower unit, which he called the Danforth beds, consisting of "interfingering layers of till and sand with minor silt and silty clay"; and an upper unit, which he named the Thorncliffe beds, with "a basal part of silt and varved clay, and an upper sandy part". In his Figure 16, p. 25, he shows the till-varved-clay complex of the Don Valley brickyard as part of the Danforth beds; and, on page 26, he refers to the occurrence of Thorncliffe beds on top of the complex and overlain by Leaside Till in the Leaside section.

Several difficulties arise out of the use of these rock names, as defined by Terasmae. First of all, much of the uppermost till layer in the Seminary section is now known to be not the Leaside Till, but an older till, to be named the Meadowcliffe Till; therefore the underlying sediments are probably older than at least much of the Thorncliffe beds where they underlie Leaside Till in the type section at Leaside. Since the Thorncliffe beds are inferred to have their type section at the Bluffs, the term could only strictly be applied to the sediments, and their correlatives elsewhere in the Bluffs, which underlie the Meadowcliffe Till. It is apparent that this was not Terasmae's intention. In fact, it has been found that sediments, similar to those described by Terasmae as Thorncliffe beds, occur between each of the tills in the Bluffs, as well as between Sunnybrook Till and Leaside Till in inland sections along the rivers.

The results of this study, together with many observations by the author in other parts of Metropolitan Toronto, suggest a revision of nomenclature. At this time it seems practical only to lump together all these sediments in one unit, here named the Thorncliffe Formation, with its type section in the Hi section (Fig. 5, A1020) where four Wisconsinan tills are exposed with their intervening stratified beds. Lithologically it includes a variety of well-sorted sands, silts, and clays, including varved clays. To the north, the Thorncliffe Formation is a single series of sands and silts between the Leaside Till and Sunnybrook Till; the two other tills which appear in the Bluffs do not extend far inland. A major unit of silt and clay at the base, resting on the Sunnybrook Till and well-exposed at the Don brickyard and in the Dutch Church section, is given a separate designation, the Bloor Member, which will be discussed later. The author's conception of the Thorncliffe Formation is shown in Figure 16.

The Thorncliffe Formation varies greatly in thickness; in the Bluffs, it ranges up to 150 feet, not including the intervening Meadowcliffe Till and Seminary Till. Over half of the sediment is stratified fine sand, the rest being dense silt and varved clay.

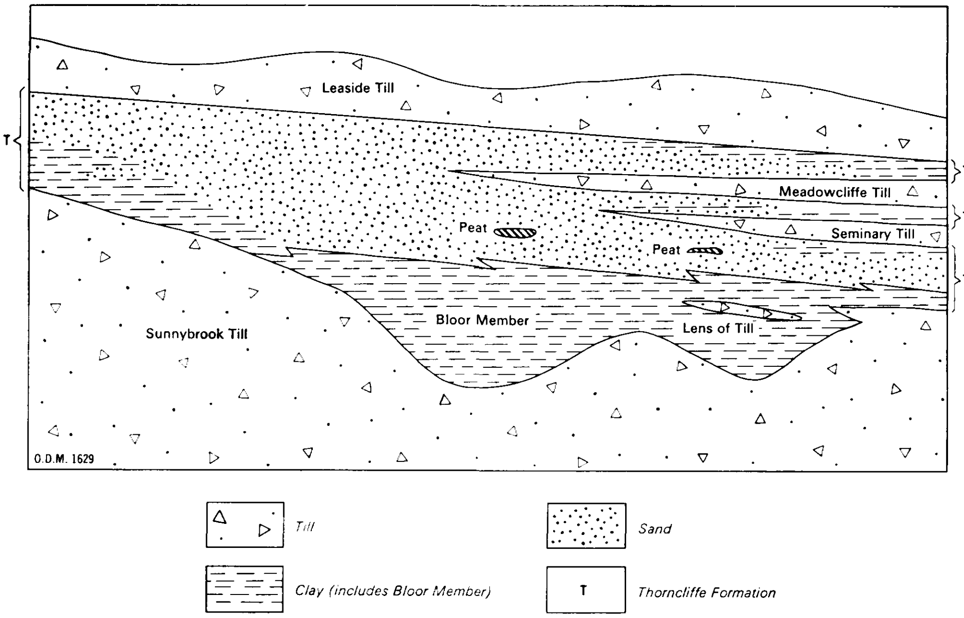

Figure 16—Relationship of Thorncliffe Formation to older and younger tills.

Inland it averages 25 feet thick along Massey Creek and 60 feet on West Duffin Creek; on other streams it forms a thin unit 5 to 20 feet thick.

A detailed study of the varves was made by Antevs (1928). He found over 1,200 varves in all. He established a correlation of varves and ice advances from section to section in the Bluffs and in the Don brickyard. The present study supports many of the details of Antevs' work.

While these sands and clays are generally unfossiliferous, visible plant remains have been found in sand at four localities a few feet above the Sunnybrook Till, thus suggesting a possible interstadial origin. Samples from these localities (F120, A1013, A1014, A1017) were submitted to J. Terasmae for pollen study (see Appendix B for details). The samples were reported to contain pollen of such a character as to suggest deposition during a cold boreal climate similar to the conditions obtaining when the Scarborough Formation was deposited. The question as to how much of the material has merely been reworked from the Scarborough beds cannot be settled as yet; but at least some of the pollen is believed to be from plants growing in postScarborough interstadial time. Unfortunately insufficient material was present for dating at three of the localities. Two samples from A1014 have been dated as 38,900 ± 1300 years (GSC-271) and 48,800 ±1400 years (GSC-534). Further dating is desirable on these beds.

In connection with this problem, samples of three of the associated tills were also studied for pollen, and a suite of plants similar to the Thorncliffe and Scarborough beds was found. It was reported by Terasmae that:

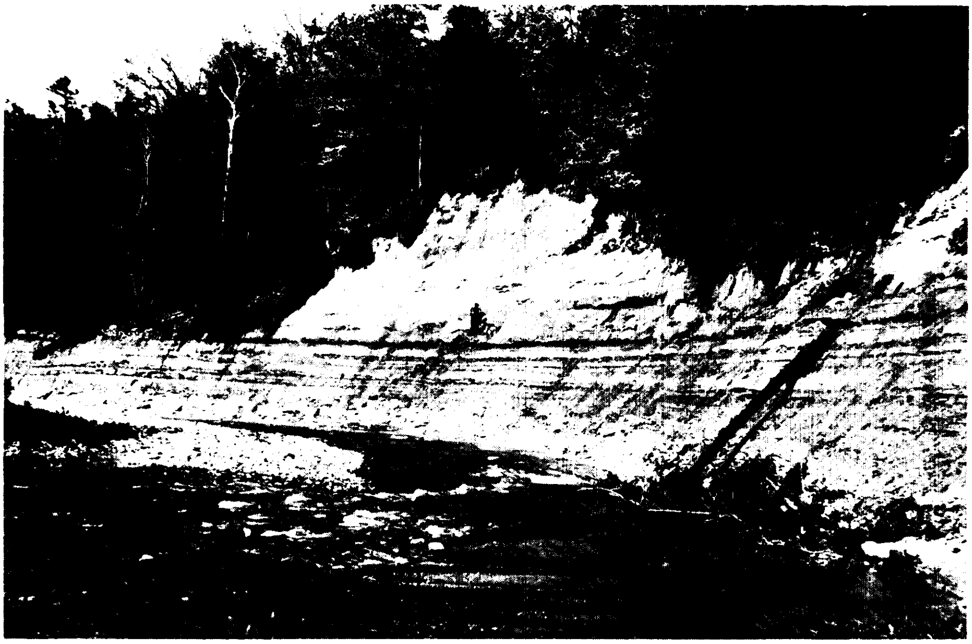

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Photo 7—Stratified sand and silt of the Thorncliffe Formation along West Duffin Creek (J47).

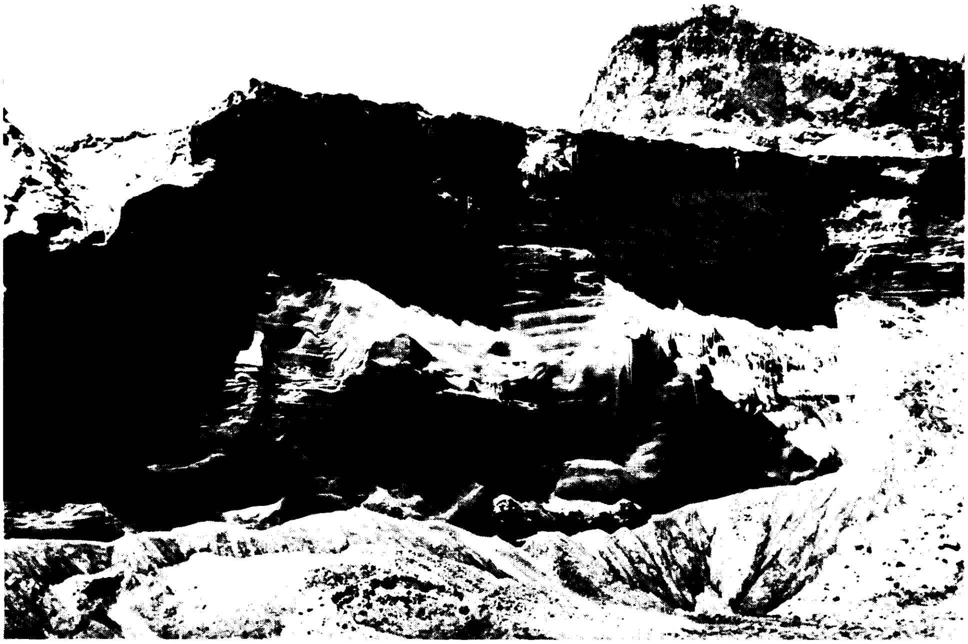

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Photo 8—Deltaic sands of the Thorncliffe Formation. Sabiston pit, east of Thornhill.

. . . the Sunnybrook till probably contains material redeposited from the Scarborough Beds and from whatever deposits, if any, were present above the Scarborough Beds and were subsequently eroded. Tills No. 2 [Seminary Till] and No. 3 [Meadowcliffe Till] may also contain some redeposited Scarborough Beds but more likely the material is from sediments laid down since the deposition of the Sunnybrook Till.

It seems probable therefore that the inter-till sediments may represent deposition during an interstadial interval (or intervals) when the ice margin fluctuated in the Toronto region.

Another locality within the report-area at which buried organic remains have been found is the Markham Sand and Gravel pit near Amber. Basically the sequence consists of gravel under Leaside Till and over Sunnybrook Till; it has been described previously by Dreimanis and Terasmae (1958). Over the years, balls of till, clay, and peat have been found in the gravel. Another ball of organic material was found by the author half-way up the south face of the pit during the summer of 1960 and was submitted to a radiocarbon laboratory for dating; as yet no results have been reported. Previous dates on peat balls from this pit have been beyond the range of dating (W-194>34,000 years; S-26>23,000 years). Analysis of earlier finds revealed cool-climate pollen, but none was found in the most recently discovered peat ball, presumably the pollen having decomposed. Dreimanis and Terasmae have correlated this material with the Port Talbot interstadial deposits on Lake Erie and with buried peaty sand found in the Yonge Street subway near Jackes Avenue.

In summary, the age of the Thorncliffe Formation remains uncertain, but it seems probable that at least part of it represents a midWisconsinan interstadial deposit. The two Carbon-14 dates so far available support this conclusion.

The genesis of the deposits must now be considered. Most of the sediments appear well sorted and evenly bedded; and, since varved clay constitutes a significant proportion of the sediments, they are most likely lacustrine with stream sediments appearing at higher elevations. Several series of varves are present in the sequence, thereby suggesting the former existence of a series of temporary glacial lakes at various levels. Two large masses of uniform sand are included in this unit; they may represent deltas formed at the mouths of rivers flowing from the north. These buried deltas (they are overlain by Leaside Till) are well-exposed in sand pits. Mechanical analyses show them to be very well sorted sands with median diameters of 0.155 millimetres (Regan sand pit at Morningside Drive and Ellesmere Road) and 0.180 millimetres (Sabiston sand pit, 2 miles east of Thornhill).

The Bloor Member is the name applied to the lower part of the Thorncliffe Formation; it has its type section at the Don Valley brickyard. The term approximately corresponds to the Danforth beds of Terasmae but replaces it because the term Danforth is pre-empted in the local bedrock nomenclature. The Bloor Member consists of varved clay and silt and includes some lenses and tongues of the underlying Sunnybrook Till, on which it rests at the brickyard and the Dutch Church section; correlation of the two varve series has been established by Antevs (1928). In addition the Bloor Member is known to occur west along Bloor Street at least to Avenue Road, where it was well-exposed during subway construction. It appears to occupy depressions in the surface of the Sunnybrook Till, with which it is closely associated. Its only known occurrence in the Scarborough area is in the Dutch Church valley; varved clays on Massey Creek may also be part of the same unit.

Seminary Till

Seminary Till is the name here proposed for a sheet of till in the Bluffs which overlies stratified clay and sand above the Sunnybrook Till; it is the next till above the Sunnybrook Till. The type locality is the Hi section (Fig. 5, A1020). The name is taken from St. Augustine's Seminary, a prominent Scarborough landmark.

Analyses of eight samples of this till yielded an average of 33 percent clay, 30 percent silt, and 37 percent sand; till matrix averaged 18 percent calcite and 7 percent dolomite, with a carbonate ratio of 2.7. Pebble counts on four samples averaged 55 percent limestone, 5 percent dolomite, 30 percent shale, and 10 percent Precambrian.

Seminary Till is traceable in every section from the Seminary section (A1009) east to section A1013. Erosion by Lake Iroquois apparently eroded it away in Bluffs sections to the east and west with the one exception of A1005 where a lens of the till overlies varved clay filling the Dutch Church valley; Antevs (1928) recorded this till lens in one of his sections.

The Seminary Till is usually thin, but varies from nearly zero thickness up to 26 feet. Where it is very thin, it also occurs at higher elevations, suggesting thinning over the crest of a knoll; this may be a primary feature of deposition or may have been caused by erosion. Previous workers have either made only routine mention of a till in this position (Coleman 1932; Antevs 1928) or have not recognized a distinct traceable till unit (Watt et al. 1953; Terasmae 1960). This study indicates no great inland extension of this till; it has not been identified north of the Bluffs.

Coleman (1932) considered this till to be part of the "middle complex" which he interpreted as recording ice advances and retreats of Illinoian age. The occurrence of plant remains in sand between the Sunnybrook Till and the Seminary Till and the composition of the latter suggest that the major nonglacial break preceded the deposition of the Seminary Till. It is therefore tentatively concluded that the Seminary Till is a minor till sheet deposited during the advance of the Late Wisconsinan ice.

Meadowcliffe Till

The third till above the Scarborough Formation, and the next above the Seminary Till, is here named "Meadowcliffe Till" after the street of the same name where the till is well-exposed in gulleys cut into the Lake Iroquois Bluff. The beds above and below the till, however, are best exposed in the Hi section; so this is designated the type section.

Typically, a few feet of varves occur near or at the base of the till. These varves are generally thin-bedded and can be recognized in most of the Bluffs sections where this till is exposed. The till is overlain by the uppermost part of the Thorncliffe Formation in the Bluffs, which includes over 400 varves.

Texturally, this till sometimes resembles Sunnybrook Till, and in inland sections, where sequences are incomplete, it is often difficult to distinguish the two. Analyses, however, have revealed differences. Meadowcliffe Till (nine samples) averaged 54 percent clay, 35 percent silt, and 11 percent sand; till matrix contained 24 percent calcite, 6 percent dolomite, and had a calcite-dolomite ratio of 4. Pebble counts (four samples) yielded 58 percent limestone, 5 percent dolomite, 18 percent shale, and 19 percent Precambrian.

The thickness of the Meadowcliffe Till in the Bluffs is quite uniform, varying from

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Photo 9—Section (C165) on Highland Creek exposing Leaside Till, Meadowcliffe Till, and Sunnybrook Till.

35 to 40 feet. Inland, it varies from zero to perhaps as much as 80 feet. Identification of this till inland being uncertain makes statements about its distribution hazardous, but it is definitely present in some (e.g. C165) (see Photo 9) and probably in several sections on Highland Creek; a few sections on Rouge River may also include this till.

The presence of this till was indicated in Antevs' varve study and correlated by him in much the same way that the present mapping suggests. It appears to extend farther to the north than the Seminary Till but it is still of limited known extent. Coleman (1932) recorded the presence of this till in the Hi section of the Bluffs (Fig. 5, A1020). Like the Seminary Till, the author considers the Meadowcliffe Till to represent a minor ice advance just prior to the major Late Wisconsinan ice advance. The fine texture of this till probably results from the incorporation of lake deposits in the Ontario basin; thus the ice must have moved northwest across the area.

Leaside Till

This till has been named by Terasmae (1960) who correlated the uppermost till in the Seminary section with that in the railway cut at Leaside station described by Coleman (1932). This correlation has been shown to be invalid, thus confusing the nomenclature. It is here proposed that the Leaside Till have its type section in the Leaside cut. Till, correlative with the Leaside Till of Leaside, does occur in the Bluffs; it is best exposed in the Hi section where it overlies varved clay and sand of the Thorncliffe Formation and forms the youngest till exposed in the Bluffs. This till has been found to be the uppermost throughout the area, forming the surface material in most places; in most exposures it overlies stratified sediments assigned to the Thorncliffe Formation.

Dreimanis and Terasmae (1958) described a "middle till" and an "upper till" from the Toronto area. In the Scarborough area, a few sections reveal comparable tills which appear to represent two ice advances separated by a very short time interval. Only kamy sand and gravel have been found to separate the two tills. As a general rule, the tills are similar, but the lower one is sometimes coarser and stonier than the upper, although the reverse has been seen too. Such differences have been observed along the Rouge River and Massey Creek; along West Duffin Creek, there is usually a sand seam about the middle of the till which suggests a consistent break in deposition. In many, and perhaps most, exposures of the uppermost till, however, there seems to be no indication of any break in deposition, and, lithologically, the till seems most like the "upper till" of Dreimanis and Terasmae.

Comparisons by Dreimanis and Terasmae, and Ostry (1962), show differences in pebble lithology; with the upper unit higher in shale and lower in dolomite than the lower unit. Fabric studies by Ostry show consistently northwest trends for both till units, whereas Dreimanis and Terasmae find varying directions for the lower unit. In summary, then, evidence from the field and laboratory suggests the presence of two closely-related till layers separated by thin discontinuous sand and gravel.

But, because the two layers are so similar, they are grouped together in this report—i.e. most exposures are considered to be "Leaside Till, undifferentiated", and analyses will be reported on this basis. In reaching this decision, the hypothesis was considered that the lower unit might be the northward extension of the Seminary Till, but study of field relationships and analytical data refuted the theory; the lower unit was found to be more similar to Leaside Till than Seminary Till.

Lithologically, Leaside Till is a silty sand till containing (46 samples) 20 percent clay, 33 percent silt, and 47 percent sand, with an average till matrix composition, for 26 samples, of 25 per cent calcite and 6 percent dolomite; carbonate ratios averaged 4.0. Pebble counts on eight samples averaged 71 percent limestone, 14 percent shale, and 14 percent Precambrian. Till fabric at four localities indicates ice movement to the northwest parallel to trends indicated by flutings on the till surface (see Photo 2) and the trend of the long axes of drumlins.

Some general trends of areal variations have been noted. Clay content seems to be consistently high (about 30 percent) in the high central part of the Bluffs where varved clay underlies the till. Elsewhere, clay content usually ranges between 10 and 20 percent; along the Rouge River, values are erratic. Carbonate ratios are highest in the area in the northeast (ratios of 5 to 1 or greater); in the southeast they are less than 3 to 1; and elsewhere they are between 3 to 1 and 5 to 1. The high ratios in the northeast probably reflect the nearby outcrops of limestone in the vicinity of Oshawa and Whitby.

Leaside Till is a relatively thick till sheet averaging 40 to 50 feet thick along most stream valleys. It appears, however, to thin out over the crest of the Scarborough delta; and along Highland Creek and in the Bluffs it is only 10 to 20 feet thick. Its general distribution indicates that the ice advanced over a landscape quite similar to the present one, depositing a substantial sheet of till which completely covered the area. Later erosion by streams and by Lake Iroquois has removed some of the till; deposition by meltwater streams, ponds, and lakes has covered the till in small areas.

Until recently, this till sheet was considered to be of Valders age (10,000 to 11,000 years old) but the radiocarbon dating of the subsequently occurring Lake Iroquois at 12,000 years has necessitated an upward revision of its age. It is now considered to have been deposited during the retreat of the Mankato ice sheet. While its extent has not been traced definitely, it is believed to correlate with the Halton Till and Wentworth Till of the Hamilton-Galt area (Karrow 1963).

No significant break in the retreat of the last ice sheet from the Niagara Escarpment has been found between Hamilton and Toronto. Regional correlations suggest that the lower part of the Leaside Till may be equivalent to the Wentworth (as well as older tills?) and the upper unit to the Halton Till. As conceived by the author, the Leaside Till represents the Late Wisconsinan (also known as the main or classical Wisconsin) ice advance in the Scarborough area.

Postglacial Lake Deposits

At numerous places in the area, the Leaside Till is overlain by stratified sand, clay, or silt, attributed to deposition in lakes or ponds which existed during and after ice retreat. The most extensive of these deposits (excluding Lake Iroquois deposits to be discussed presently) are to be found along the Rouge Valley in a broad basin southwest of Markham. No shoreline features have been found to indicate the level of the water at the time but the distribution of lake sediments suggests it was somewhat greater than 650 feet above sea level. Correlation with pre-Iroquois lakes identified in New York State (Fairchild 1919) is as yet impossible.

The lake sediments include a great variety of materials representing all the complex variations of sedimentary environment at the edge of the ice. In some places, Leaside Till grades upward into a stony varved clay, no doubt recording the retreat of the ice edge in standing water. Examples of this may be seen in road cuts at the intersection of highways 7 and 48 in Markham. Varving is rare and poorly developed at best. More often a more irregular stratification is present. Silt and clay are more common in the lower part of the sequence, and they often grade upward into stratified silt and sand or pure sand, probably due to shoaling of the water as the lake was drained during ice retreat.

The stratified clays and silts seem to be at their maximum thickness between Unionville and Markham, where they are over 15 feet thick in places. Elsewhere they are only 3 to 5 feet thick and tend to blanket the underlying till while modifying the till landforms very little. The overlying sand averages 3 to 4 feet thick although locally it may be much thicker. Some of the sand may be alluvial, but the lower contact is gradational, and the extent of the sand is suggestive of a lacustrine origin.

A string of pond deposits flanks the Rouge valley from Markham to Finch Avenue. The clays are found in flat-bottomed depressions and are usually 3 to 4 feet thick. One deposit just north of Finch Avenue is exposed in section F17 (see Appendix A) which reveals a typical sequence of sediments. Numerous other isolated bodies of pond sediment are scattered across the Leaside Till plain, located in original depressions in the till surface. Frequently they have been covered by later swamp and bog deposits and now may be the only forested areas for miles around.

The lowest lake deposits are those of glacial Lake Iroquois. The landforms

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Photo 10—Lake Iroquois beach sand and gravel; Beare Road near Finch Avenue.

associated with this lake have already been described. The fine-grained deep-water deposits are of limited extent, generally located in depressions between drumlin ridges on the surface of the Leaside Till within a mile of Lake Ontario near Port Union. Some of the sediments consist of water-laid till which grades up into varved silt and clay as much as 5 feet thick. A typical section east of the Pickering Town Line, ½ mile north of Port Union, is as follows:

2 feet of sandy brown soil
1 foot of stratified buff silt and sand in lenses
1 foot of varved clay, varves ½-inch thick
1 foot of brown clay containing silt balls
2 feet of sandy stony silt till

North toward the shoreline and in the shallow-water environment of Lake Iroquois, there is a belt of stratified fine sand which thickens and becomes interbedded with gravel as the old shoreline is approached. Along the shoreline there are stratified gravels formed into broad ridges or spits by longshore currents in Lake Iroquois (see Photo 10). The gravels are the result of the erosion of till (principally the Leaside Till) by the waves of Lake Iroquois. Most of the gravels are medium- to fine-textured and rounded. Because of their close proximity to Toronto, these gravels have been exploited for many years, and now the deposits that remain are mostly covered by housing and other urban development. A large volume of gravel was removed by Highland Creek near Lawrence Avenue; this gravel no doubt was deposited downstream near the lake, where it now lies submerged under rising lake water.

Careful search revealed the presence of fossil shells in Lake Iroquois sediments at only one locality in the Scarborough area — in a gravel pit between Sheppard Avenue and Highland Creek, west of Kirkham's Road. The situation is that of a lagoon sheltered behind the gravel bar which lies to the east and near where the Rouge River entered Lake Iroquois. The forms recovered from a silt band in the sands are listed here as identified by A. H. Clarke and H. B. Herrington:

Pisidium casertanum (Poli)
P. compressum Prime
P. lilljeborgi Clessin
P. subtruncatum Malm
Fossaria c.f. *owascoensis* Baker (probably a local variant of *F. humilis* Say)
Fossaria sp.
Valvata sincera Say
V. tricarinata (Say)
V. tricarinata perconfusa Walker
Gyraulus parvus (Say)
Gyraulus sp.
Oxyloma retusa (Say)
Retinella electrina (Gould)

West of Wynnview Crescent (A1004A), along the Bluffs, the Sunnybrook Till gradually lowers in elevation until it reaches Lake Ontario level near Victoria Park Avenue. Overlying the till is a wedge of stratified sand and gravel which thickens westward from 25 feet at Wynnview Crescent to more than 90 feet at Victoria Park Avenue. Even where the Sunnybrook Till is missing at Birchmount Road, the contact between this sand and underlying Scarborough sand is distinct. Sand predominates in these beds. The exposures are located only ¼ to ½ mile south of the Lake Iroquois gravel bar and are believed to represent a section through deposits slightly offshore from the bar. It may have been erosion by Lake Iroquois waves, when that lake was at an earlier lower level, that removed the Sunnybrook Till near Birchmount Road.

In some areas along the Lake Iroquois shoreline, erosion, rather than sedimentation, was the dominant activity. In these areas, now marked by well-developed shorecliffs, erosion of the shore materials left behind only the coarsest material which the waves and currents could not move. The result is a concentration of boulders in front of the shorecliff such as may be found near Cherrywood Station.

At Cudia Park (A1014) an interesting exposure through Iroquois sediments at the base of the old shore bluff shows a basal beach deposit of gravel (4 feet thick), which lies on an erosional surface cut in Thorncliffe sands and is overlain by 13 feet of colluvial material composed of blocks of till (probably Meadowcliffe) and varved clay from below the Leaside Till. These colluvial blocks are set in a matrix of stratified silt and sand which grades southward away from the Iroquois shoreline into clean, almost varved, stratified silt.

The shore features of Lake Iroquois have been traced around the Lake Ontario basin by many earlier workers over a period of several decades. It has long been known that the lake found its outlet at Rome, New York, and drained to the sea by way of the Hudson Valley. Only recently, however, has it been possible to obtain material suitable for dating by the radiocarbon method. Three dates from Hamilton (Ontario) and Lewiston (New York State) average 12,000 years old (Karrow, Clark, and Terasmae 1961); other dates from Hamilton on early Lake

Ontario indicate that Lake Iroquois lasted only a few hundred years and drained before 10,000 years ago. Lakes at higher levels than Lake Iroquois must have been even shorter-lived.

Stream Terrace Deposits

Along most of the main stream valleys, particularly Highland Creek, Little Rouge Creek, and West Duffin Creek, there are several abandoned terraces formed when the streams were flowing at higher levels. The oldest terraces are those now highest above the present streams.

Typically the terrace deposits consist of a basal lag gravel overlain by sand and silty sand; these sediments average 3 to 6 feet in thickness. Fossil molluscs were found up to 40 feet above the Rouge River in section F23, the highest occurrence of fossil remains in terrace deposits. A collection of shells from the 40-foot terrace was examined by H. B. Herrington of Westbrook (Ontario) and A. H. Clarke of the National Museum of Canada; they reported forms present as listed below:

GASTROPODA
- *Promenetus exacuous* (Say)
- *Gyraulus parvus* (Say)
- *Armiger cristus* (Linn.)
- *Zonitoides nitidus* (Müller)
- *Discus cronkhitei* (Newcombe)
- *Aplexa hypnorum* (Linn.)
- *Vertigo*
- *Carychium exiguum* (Say)
- *Valvata sincera* Say
- *Helisoma anceps* (Menke)
- *Physa gyrina* Say
- *Fossaria humilis* (Say)

PELECYPODA
- *Sphaerium rhomboideum* (Say)
- *S. occidentale* Prime
- *Pisidium casertanum* (Poli) two forms
- *P. casertanum,* f. *roperi* Sterki
- *P. obtusale,* f. *rotundatum* Prime

The environment indicated by this assemblage was reported as: ". . . a well vegetated, *eutrophic* lake, pond, or slow-flowing, medium to large stream. The terrestrial species, especially the *Z. nitidus,* indicate a moist or wet, probably open, habitat."

Successively lower terraces have abundant shells down to the modern terrace or flood plain. Plant remains have not been preserved in very old terraces. The highest plant remains were found in a terrace 22 feet above the Rouge River just west of Sewell's Road (F20). J. Terasmae reported no preserved pollen in the gyttja-like lens in alluvial silt and sand; a radiocarbon date was obtained on the material of 2,400±75 years (GSC-26), but pollen study of a lower terrace nearby (see p. 46) indicates this date is too young, possibly the result of contamination from modern roots growing down from the terrace surface (J. Terasmae, personal communication). Shells in the same terrace where the radiocarbon sample was collected were examined by F. P. Ide, of the Department of Zoology, University of Toronto, who reported the following woodland, other terrestrial, and freshwater forms present:

GASTROPODA
- *Helisoma antrosa*
- *H. campanulata*
- *Anguispira alternata* (Say)
- *Discus conkhitei anthyoni* (Pilsbry)
- *Zonitoides arborea* (Say)
- *Physa*
- *Mesomphix* sp.
- *Euconulus chersinus polygyratus* (Pilsbry)
- *Bulimus tentaculata* (Linne)
- *Amnicola limosa* (Say)
- *Planorbidae*
- *Planorbula armigera* (Say)
- Lymnaeidae (?)

PELECYPODA
- *Pisidium* sp.
- *Sphaerium* sp.

To sum up, then, the ages of various terrace deposits remain unknown. An upper limit on their age is set by Lake Iroquois, so that probably all of the deposits except the highest terrace on West Duffin Creek are younger than 11,000 years. Any terraces with bogs on them can have a minimum age determined by dating the lowest plant material in the bog. The same is true for Indian sites, which could be used to set a minimum age for the terrace on which they are situated. So far, no information is available from these sources.

Deposits mapped as recent alluvium are those believed to extend along only the modern flood plain of the stream. Most streams, even fairly small ones, have a flood plain. The sediments on the flood plain are similar to those on higher terraces except for a greater abundance of organic matter in the recent alluvium. Near the mouths of major streams, such as Highland Creek and Rouge River, evidence of the rising level of Lake Ontario is to be found in the deep accumulations of soft sediment (clay, silt, sand, muck, wood). Similar materials have been dated at Burlington (Ont.) (Karrow, Clark, and Terasmae 1961), and it is likely that lake level has risen about 5 feet in this area in historic times, i.e. the last 300 years.

Alluvial Fans

Small alluvial fans, built onto the Iroquois terrace at the mouths of gulleys cut in the Iroquois bluff, have already been described as a landform (see p. 20). The sediment in the fans are exposed in the modern gulleys now being cut into the present Bluffs. These sediments consist of a varying sequence of silt and sand several feet thick resting on deposits of Lake Iroquois. Buried soil profiles are to be found in the sequence and a well-developed modern soil profile, with carbonate leaching to 2 or 3 feet, is present on top.

One of the localities where a buried soil profile occurs is along the Bluffs between A1008 and A1009; it has been referred to by Terasmae (1960, p. 30) and has been described in more detail by Churcher and Karrow (1963). Of particular interest at this locality was the discovery of charcoal and shells below, in, and above the buried soil, and also mammal remains in the buried soil itself. J. Terasmae reported that no pollen had been preserved in the sediments. The mammal remains identified by C. S. Churcher are:

Tamias striatus (eastern Chipmunk): left lower incisor
Microtus pennsylvanicus (meadow vole): several teeth and fragments of skull and jaw
Urocyon cinereoargenteus (grey fox): teeth, ribs, scapulae, left humerus, and fragments of skull, legs, and toe-bones.

Charcoal samples were examined by R. W. Kennedy, University of Toronto, who reported:

Pinus strobus L. (white pine)
Acer saccharum Marsh. or *Acer nigrum* Michx.f. (hard maple)
Fagus grandifolia Ehrh.? (beech)

Radiocarbon analyses by the University of Saskatchewan on the charcoal yielded:

S-115A	5,550 ±	70 years
S-115B	5,240 ±	100 years

Identifications of the shells have recently been obtained from A. H. Clarke and H. B. Herrington as follows:

I. Shells above buried soil

GASTROPODA
- *Triodopsis albolabris* (Say)
- *Retinella electrina* Gould
- *R. indentata* (Say)
- *Hawaiia minuscula* (Binney)
- *Helicodiscus parallelus* (Say)
- *Physa gyrina* (Say)
- *Discus cronkhitei* (Newcombe)
- *Gyraulus parvus* (Say)

PELECYPODA
- *Pisidium casertanum* (Poli)

II. Shells in and below buried soil

GASTROPODA
- *Hawaiia minuscula* (Binney)
- *Retinella electrina* Gould
- *Discus cronkhitei* (Newcombe)
- *Triodopsis* sp.

The accompanying comments were as follows:

I—Probably represents a small or medium sized eutrophic pond in a deciduous or mixed woodland environment. The absence of *Valvata* among the freshwater species implies a rather limited environment (i.e. a small body of water). *Triodopsis* occurs only in wooded areas.

II—Mixed deciduous-conifer, or deciduous, woodland.

All the above data are quite consistent with a warm climate such as is known to have existed about 5,000 years ago during a time known as the "climatic optimum" when it was slightly warmer than present.

A second locality at which charcoal and shells were found in an alluvial-fan deposit on the Iroquois terrace is at A1014. Shells have not yet been identified from this locality.

It is evident that sedimentation was active in these fans over 5,000 years ago when there was a warmer climate. Perhaps the wooded slopes above the Iroquois terrace were set on fire by lightning or perhaps by primitive man; streams carried the burned wood into the alluvial fans along with bones of mammals caught in the fire (the bones are partly calcined by fire). Snails and clams lived on the forested slopes, in the stream, and in depressions on the fan itself.

Swamp and Bog Deposits

In undrained or poorly drained depressions in the till plain or in abandoned stream channels, shallow deposits of partly decomposed plant matter have accumulated. These deposits are small in area and few in number and are distributed mainly through the central part of the area. The maximum depth of the deposits is about 7 feet but they are usually only 3 or 4 feet deep.

In the bottom of some of the bogs there is an accumulation of cream-coloured shelly marl deposited when there was open standing water in the depression. Pollen from one of these marly bogs was studied by J. Terasmae, who reported a cool boreal-climate assemblage of a type having an age of about 7,000 to 8,000 years (see Appendix B). The location of this bog on a low-level terrace of the Rouge River, 1 mile south of Box Grove, has to a large extent discredited the date of 2,400 years obtained for the 25-foot terrace of the Rouge.

Lake Ontario Deposits

Rising water level in Lake Ontario has submerged all but the narrow strip of sediments now found on the beach at the foot of the Bluffs. These sediments are the product of the erosion of the tills, sands, and clays in the Bluffs and rest on a wave-cut platform eroded mostly in Scarborough clay. Boulders eroded out of the till formerly helped to protect the base of the Bluffs from erosion but were all removed many years ago for building house foundations in Toronto. Sediments presently to be found on the beach consist mainly of sand, a few inches in thickness, and occasionally a little gravel.

Offshore deposits have been described by Kindle (1925).

HISTORICAL GEOLOGY

Consideration of the Pleistocene history of the area leads to a summary of the information at hand on the distribution, nature, and significance of the various deposits. It is mainly interpretative; and, because of ever-present gaps in our knowledge, is subject to modification as new information becomes available.

The earliest Pleistocene event of which we have record is a glaciation, which is currently believed to be of Illinoian age. At that time, more than 100,000 years ago, cool climates brought about the accumulation of snow and ice in northern Canada, leading to the development of great ice sheets which spread out in all directions. A part of the ice sheet advanced to the southwest, covering Toronto and extending well into the United States, as far south as the Ohio River in some places. The ice overrode shale in the Toronto area and formed a shale-rich till, the York Till. The great weight of ice no doubt depressed the land, much as it did during the next and last glaciation. Then moderating climate brought about the melting of the ice sheet. Eventually the climate became even warmer than now, the ice sheet had disappeared, and plants and animals now more typical of Pennsylvania thrived in the area north of Toronto. At that time, known as the Sangamonian Interglacial Stage, a river flowed from the north into a large lake in the Ontario basin. The lake was at least 60 feet higher than Lake Ontario is now (Coleman 1933); this may indicate the unwarped level of the outlet of the Ontario basin east of Kingston and the amount by which Lake Ontario may still rise due to postglacial uplift. At this time, the Don Formation was deposited, preserving an abundant sample of the flora and fauna of the time.

Then, as the peak of the warm interglacial time passed, and the climate became at first a little cooler, then much cooler, glaciers again formed in the north and spread toward the Great Lakes area. When the ice reached the east end of the Ontario basin, it dammed up the outlet and raised the water level until drainage was diverted down the Mohawk and Hudson valleys to the sea. A large delta was formed on the north edge of the lake (Lake Scarborough[1]) at the mouth of a large river flowing from the north. The sediments of this delta, the Scarborough Formation, contain the remains of plants and animals native to a cold, boreal climate. This ice advance, based on the age of a sample of wood from the upper Scarborough sands, and on ages of buried wood near Trois Rivières (Que.), occurred more than 50,000 and perhaps as much as 70,000 to 80,000 years ago. Ice retreat then allowed the lake level to fall as drainage returned to the St. Lawrence valley, and the delta was dissected by streams.

Further cooling of the climate brought about a major ice advance, of Early Wisconsinan age, which completely covered the area. Sediments in the lake basin were incorporated by the ice to form a fine-textured till, the Sunnybrook Till. Judging from the content of purple garnet, dolomite, and sandstone, the ice must have flowed southwest across the Ottawa-Cornwall area, into the Ontario basin, and westward over the Scarborough delta. Westward extensions of the advance are uncertain but may possibly be recorded by the Canning Till near Paris (Karrow 1963) and older tills encountered in borings along the north shore of Lake Erie (Dreimanis, Terasmae, and McKenzie 1966).

A moderating climate later caused this ice sheet to melt back. As it retreated eastward through the Ontario basin, a lake was formed whose level roughly coincides with the top of the Scarborough sands, as well as with the later level of Lake Iroquois; use of the Rome outlet into the Hudson valley while ice blocked the St. Lawrence is again indicated. Sediments deposited in this lake include the varved clays of the Bloor Member.

A substantial ice retreat of unknown magnitude occurred at this time. Cold-climate plants again invaded the area; peat bogs were probably numerous. This time of

[1]Editor's Note: In 1878, G. J. Hinde used the spelling Scarboro' for both geological and geographic names, probably as an abbreviation for the correct and legal spelling Scarborough. Coleman's "The last million years", published posthumously in 1941, followed the same style but omitted the apostrophe even in quoting the Hinde work. A. P. Coleman's work, during his lifetime when published and indexed by Ontario Dept. Mines, used the spelling Scarborough (in full) for both geological and geographical names, and this is the accepted Departmental usage.

cool climate is considered to be a major break within the Wisconsinan Glacial Stage. Sediments of the Thorncliffe Formation were deposited at this time. Probably the same period of glacial recession has been recorded in the Lake Erie area by the Port Talbot interstadial deposit and in Ohio by the Sidney interstadial peat (Dreimanis 1960). The period has been radiocarbon-dated as beginning about 50,000 years ago.

It is likely that plant detritus above the Sunnybrook Till in the Bluffs, peat balls at Amber, and plant detritus in the Yonge Street subway date from this time: confirmation must await further dating. Possibly a major lake stage in this interval, having its outlet at Rome at the Iroquois level, cut the shorecliff-like feature, later overridden by glacial ice, shown in Watt's subway cross-section (1954). This lake stage may also have been the agent that eroded away the Sunnybrook Till at about the same level along Highland Creek and Rouge River.

Another interval of cold climate brought about the advance of the last major ice-sheet about 30,000 years ago. The advance was pulsating, forward thrusts alternating with short retreats. Two of these short advances are probably represented by the Seminary Till and Meadowcliffe Till; to the north, beyond the ice front, sediments of the Thorncliffe Formation continued to accumulate. The fluctuating ice-front had again dammed up the water in the Ontario basin, causing varved clays to be deposited between each till sheet.

Eventually the ice advanced strongly over the area, depositing the lower unit of the Leaside Till; and, extending southwest, reached the Ohio valley about 20,000 years ago. Fluctuations of the ice are recorded in the numerous end moraines of the midwestern United States and southwestern Ontario; ice advances named the Tazewell, Cary and Mankato deposited distinctive till sheets in that area while ice covered the Toronto district continuously. Suggested correlations are shown in the accompanying table. The first ice retreat to extend eastward far enough to uncover the Toronto area is recorded in the break between the Wentworth and Halton tills of the Hamilton area (Karrow 1963) and the upper and lower units of the Leaside Till in Scarborough. After a brief retreat, the ice advanced for the last time in this district, extending westward to the Niagara Escarpment. The Halton Till was deposited west of Toronto.

Suggested Correlation Chart

<table>
<tr><th></th><th></th><th></th><th>HAMILTON-GALT</th><th>SCARBOROUGH</th></tr>
<tr><td rowspan="7">WISCONSINAN</td><td rowspan="6">LATE</td><td rowspan="2">Mankato</td><td>Halton Till</td><td>Leaside Till (upper)</td></tr>
<tr><td>Wentworth Till</td><td rowspan="3">Leaside Till (lower)</td></tr>
<tr><td>Cary</td><td>Port Stanley Till</td></tr>
<tr><td rowspan="3">Tazewell</td><td>Catfish Creek Till</td></tr>
<tr><td rowspan="2"></td><td>Meadowcliffe Till</td></tr>
<tr><td>Seminary Till</td></tr>
<tr><td>EARLY</td><td colspan="2">Canning Till (?)</td><td>Sunnybrook Till</td></tr>
<tr><td colspan="4">ILLINOIAN</td><td>York Till</td></tr>
</table>

Gradually, warming climate melted the glacier away; the meltwaters were dammed up around the periphery of the lobe of ice that lay in the Ontario basin. The peripheral lakes (e.g. Lake Peel in Peel county) at intervals dropped in level as lower and lower outlets were uncovered by the retreating ice. Then for several hundred years the outlet was stabilized at Rome, New York, while ice retreated to the St. Lawrence valley. At this time, 12,000 years ago, the shore features of Lake Iroquois were formed.

The land was depressed by the weight of the ice, but slowly recovered its more normal level during and after the retreat of the ice. This recovery lagged considerably behind the retreat of the ice so that when the St. Lawrence valley became free of ice, the outlet sill of the Ontario basin was still at a very low elevation, and the waters of Lake Iroquois drained to more than 200 feet below the present level of Lake Ontario. At that time, over 10,000 years ago, Lake Ontario was born. Gradual uplift of the outlet has raised the lake level to its present elevation and has tilted the old shoreline of Lake Iroquois up to the east. During this 10,000-year interval, streams eroded valleys into the glacial deposits of the area; rising lake level has flooded the lower part of their courses. At the same time, shore erosion has cut away the south edge of the area, cutting back probably more than a mile from its low-water shoreline.

ECONOMIC GEOLOGY

General The Pleistocene deposits of the Scarborough area affect economic activity in a diversity of ways. First of all, certain types of deposits are useful materials, and these are, or can be, exploited in sand and gravel pits, clay pits, peat and muck workings, and borrow pits. In other cases, materials vary in their usefulness *in situ* as a base for foundations and roads, as the parent material for agricultural soils, as a source of groundwater, and, conversely, as a waste disposal medium.

Other problems include that of erosion along the Bluffs, and its relationship to the nature of the sediments exposed in the cliffs. All these aspects are potential considerations in planning land use — e.g. in choosing industrial areas or recreational areas; Hewitt (1962) has emphasized the economic importance of considering mineral resources in planning land use. Rapid urbanization is an acute problem for conservation of natural resources in this area.

Clay

No deposits of clay in the area are being used for ceramic products at present. The large deposits of clay close to the centre of Toronto have for several decades provided large quantities of brick close to the largest market in Ontario. The presence of substantial reserves in the Toronto deposits and the existence of a thriving ceramic industry west of Toronto tend to discourage exploration in new areas east of Toronto, such as Scarborough. Also study of the distribution of clay in Scarborough reveals that most of the suitable deposits are under too thick an overburden to allow profitable exploitation. Of course, urbanization has become a new kind of "overburden" which has covered large areas and removed them from consideration. In spite of these problems, some discussion of existing deposits seems warranted.

HSCL1

Photo 11—View of the Scarborough Bluffs taken in 1947. See Photo 12 for results of fifteen years' urban development.
(Photo courtesy of Hunting Survey Corporation Limited, Toronto.)

HSCL2

Photo 12—View of the Scarborough Bluffs in 1962 showing rapid urban expansion.
(Photo courtesy of Hunting Survey Corporation Limited, Toronto.)

Three main types of clay deposits are possibly useful for ceramic products: Scarborough clay, interstadial varved clay of the Thorncliffe Formation, and postglacial lake clays. The first two types are the basis for clay extraction in Toronto.

Scarborough clays are believed to underlie most of the report-area. Only in one place, however, is there believed to be ready access to these beds: east of Morningside Drive along the Bluffs, only a fairly thin layer of Leaside Till covers the clay, and there is as yet little construction in the immediate area. This clay is known to be red-burning, because of a low lime content, and would probably be the best choice of clay in the area.

The next best clay would likely be varved clay. The thickest deposit is in the Dutch Church section of the Bluffs, where there is the added advantage of thin overburden. But rapid postwar building (see photos 11, 12) has eliminated this source.

The Thorncliffe Formation also includes substantial thicknesses of lacustrine clay in the vicinity of West Duffin Creek. However, there is a thick overburden to remove. An accessible location might be found in a river terrace where erosion had removed most of the overburden. Because of a high lime content, the interstadial clays are buff-burning.

Of least interest are the postglacial clays. They are of limited and irregular extent. Their chief advantage would be accessibility, as little stripping would be required. Scattered pebbles would likely be troublesome. These deposits are likely suited to use by manufacturers of small art pottery products, where large volumes would not be needed.

Sand and Gravel

Sand and gravel is the most important mineral industry of the area. In 1962, five companies reported production of over 1,000,000 tons, valued at more than $1,000,000.[1] These producers are close to the Toronto market and have low transportation costs.

The main source of sand and gravel is now the interstadial Thorncliffe Formation, and probable kame deposits associated with the Leaside Till. The individual deposits seem to be fairly homogeneous as to composition, but there is a considerable difference between the various deposits; the most critical constituent in these gravels is shale and siltstone, derived from the underlying Dundas Formation. Although it is probable that additional sources of this type will be found, the fact that they lie buried under the Leaside Till will make their discovery largely a matter of chance.

A now nearly depleted source of sand and gravel is the beach deposits of Lake Iroquois; gravel bars formerly provided substantial quantities of gravel (Photo 10). On the average, the Iroquois gravels are of higher quality, being lower in shale and better sorted than the interstadial gravels. As this source has been reduced, deposits farther from the crest of the gravel bar have been excavated; these deposits are thinner, finer-grained, and in general of lower quality. Only very limited production can be expected from Iroquois deposits in the future.

[1]Ontario Dept. of Mines statistics

A third, and also minor, source of gravel is modern stream alluvium. Deposits are thin and sporadic, and their composition can be expected to be quite variable. In some degree, they are a "renewable resource", since spring floods bring down an annual load of gravel eroded from upstream. Exploitation of these gravels has been confined to the Rouge River and West Duffin Creek. Old workings also exist in some of the older stream-terrace deposits. Some of the terrace gravels are still untouched; reserves are small.

A restudy of the sand and gravel industry has recently been conducted by the Ontario Department of Mines and has been reported on by Hewitt and Karrow (1963).

Peat and Muck

The rapid growth of suburban housing in this area has created a large demand for topsoil and humus. The small and thin deposits of peat and muck in the area provide a limited source of such material close to the market. Even so, their exploitation does not support very much of a permanent industry; and supply seems to result as much as a byproduct from the development of the land for other purposes. Deposits untouched as yet will be able to supply at least part of the market in the future. Good quality peatmoss is not common in the deposits, so most of this will have to be brought in from outside the area.

Fill

As the size of construction projects increases, larger and larger quantities of fill are needed. Projects requiring large quantities of fill have included highway construction and the relocation of both Canadian National and Canadian Pacific railway lines.

Some of the production from the sand and gravel industry is used as fill. In other cases, borrow pits are excavated for the purpose of obtaining suitable fill near valley crossings and overpasses. Probably the most suitable material for this purpose is the Leaside Till, which is distributed over most of the area at the surface. Small areas of fine sand are to be found in the south, northeast, and northwest parts of the area.

Water Supply

Municipal water supply, obtained from Lake Ontario, provides water for most of the built-up part of the area. Piped distribution will no doubt be extended as urbanization spreads.

In much of the area, namely the northern part which is still predominantly rural, residents obtain water from wells which penetrate water-bearing sand of the Thorncliffe Formation, underlying the Leaside Till. These sands can generally be reached at a depth of about 50 feet; it is for this reason that deep wells are uncommon. The next lower aquifer is the upper sand of the Scarborough Formation usually reached below elevations of 400 feet. Water from these sands may be higher in iron. This unit provides many springs along the face of the Bluffs.

In restricted areas, such as along the Iroquois terrace at the Bluffs, a thin surface sand aquifer provides a few residents with water by the use of sand points. Recharge is effected by rainfall on the surface and from springs in the Iroquois bluff to the north.

Because of the very thick drift, few wells reach bedrock. Water can no doubt be obtained from the shales but may in some places be mineralized (in particular, salty).

Lack of information on the topography of the bedrock precludes discussion of aquifers in buried bedrock valleys. No doubt such aquifers exist, but only near the northern boundary can their presence be inferred from data outside the report-area.

Data on ground water occurrences may be obtained from reports by Hainstock, Owen, and Caley (1948c); and by Caley, Clark and Owen (1947a, 1947b).

Engineering Geology

Numerous problems are encountered in the practice of civil engineering, which can be anticipated to some extent by those who are familiar with the geology of the area. Costly faults in design can sometimes be avoided by heeding a word of warning; proper precautionary measures may be taken and some problems minimized or avoided.

Fortunately, most of the area is underlain by the Leaside Till; being relatively sandy and preconsolidated, good foundation conditions should generally be encountered. This till will have a high loading capacity and will stand in steep faces. Discontinuous lenses of sand and gravel may be encountered within the till but are not common; limited flows of water may be encountered in these lenses.

The beach deposits of Lake Iroquois are well drained except at depth, when they overlie clay or till, in which case a substantial flow of water may be encountered near the base; unstable excavation walls and quicksand conditions may develop. Where Lake Iroquois deposits overlie interstadial sands of the Thorncliffe Formation, such as in the vicinity of Morningside Drive and Ellesmere Road, good vertical drainage exists.

The thin sheet-like deposits of lacustrine and outwash sand will also yield water in their lower layers because of underlying impermeable materials. Where the stratified silts and clays of the peripheral lakes and Lake Iroquois occur, some settlement of foundations may be expected, since these deposits were not overridden by glacial ice and are, therefore, not preconsolidated. Fortunately these deposits are thin.

The well-known problems of organic soils need no emphasis here. Deposits in this area are sufficiently limited in extent and depth that they can be excavated completely, yielding a profitable horticultural product. Where they are not removed, excessive settlement may be expected.

At valley crossings, deposits underlying the Leaside Till will be encountered. The Thorncliffe Formation can be expected to yield water and, being fine-textured, could be troublesome when disturbed. Clays of this unit are preconsolidated. Tills

ODM7012

Photo 13—Scarborough Bluffs, showing varying erosion problems. Promontory is at the "Dutch Church".

older than the Leaside Till will make firm excavation walls; well-developed joints, particularly in the Sunnybrook Till, will aid in excavating them. Large boulders may be encountered in the tills. Deposits underlying the Leaside Till will only be encountered in the southern part of the area; at valley crossings in the northern part, older deposits will only be encountered in borings. Stream terrace deposits are mostly coarse granular materials and are thin. They will often be water-bearing. Foundation problems will mainly arise from the nature of the soil underlying the terrace deposits.

The lower part of the Scarborough sands is also water-bearing but the upper part should be either dry or easily drained. Scarborough clay is preconsolidated and should not cause problems of settlement or of slope stability. Interbedded silty sands are often very dense.

APPENDIX A

Descriptions of Measured Sections

SCARBOROUGH BLUFFS

A1000 — South of Fallingbrook Drive

Footage	
0–14	Grey-buff medium sand; slight stratification.
14–19	Well-stratified fine crossbedded buff sand and greenish silty sand. Clayey basal layer 2 inches thick with concretionary lime. Truncates subjacent bedding.
19–27	Massive to well-stratified medium buff sand. Contortions in upper foot truncated.
27–28	Dense darker-grey-buff crossbedded silty sand. This unit rises to the east and crosses subjacent bedding. Channel sand.
28–30	Buff, nearly massive, medium sand.
30–35	Silty fine crossbedded contorted dense sand.
35–36	Coarse stratified contorted buff sand.
36–41	Fine silty sand interbedded with medium sand, and brown silty clay.
41–48	Massive medium buff sand.
48–60	Interbedded yellow, buff, grey, and brown silt and sand. Concretions.
60–69	Nearly massive medium sand.
69–89	Interbedded clay and sand. Large contortions.
89–142	Slump to lake. Dug into beach and found grey soft plastic till and varved clay. Beach sand and gravel 6 inches thick.

A1001 — Just east of Warden Avenue

Footage	
0–5	Yellow mottled fine sand.
5–7	Crossbedded grey-buff coarse sand. Fine gravel at top and base.
7–12	Dense brown-and-buff silt and fine sand; crossbedded. Minor fine gravel.
12–47	Coarse crossbedded sand interbedded with fine sand. Fine gravel at 17 and 30 feet. Current westward.
47–65	Grey silt till. Inclusions of fine gravel and coarse sand near top. Blockier downward. Mica abundant. Oxidation along joints.
65–66	Lens of stratified fine sand and gravel.
66–90	Stratified peaty sand and some clay. Finer-grained downward.
90–102	Laminated peaty clay. Incipient concretions in creamy bands in lower part.
102–104	Massive silty sand band.
104–116	Peaty clay and sand with cream bands.
116–166	Slump to lake.

Scarborough area

A1002 — Corner of Crescentwood Road and Kildonan Drive

FOOTAGE

0–6 Yellow fine sand.
6–32 Grey-buff crossbedded medium sand. Some silty beds in upper part. Coarser with iron-oxide stains in lower 3 feet.
32–40 Grey silt till with mica flakes. Basal portion sandier.
40–44 Disturbed stratified clay and sand.
44–52 Stratified fine-to-medium buff sand. Peat and wood.
52–54 Dark sandy clay and peat.
54–62 Stratified brown crossbedded medium sand. Peat.
62–70 Brown contorted silty sand.
70–82 Covered but probably sand.
82–90 Sand grading into clay. Many springs.
90–96 Stratified peaty sand and clay.
96–98 Massive silt band.
98–100 Stratified peaty sandy clay.
100–102 Massive silt band.
102–146 Stratified peaty clay.
146–173 Slump to lake. Large mudflows and talus masses.

A1003 — Corner of Kingsbury Crescent and Harding Boulevard

FOOTAGE

0–2 Fine yellow sand.
2–4 Alternating grey-buff crossbedded medium sand and medium rounded gravel.
4–10 Crossbedded medium sand. Current to the west.
10–18 Fine-to-coarse rounded gravel and some sand.
18–37 Fine-to-medium crossbedded sand. Dense silty bands at 29 and 34 feet. Some fine gravel at base.
37–66 Pinkish-yellow crossbedded sand. Distinct upper contact. Limonite concretions at 49 feet. Numerous shell fragments.
66–78 Massive dense brown peaty silty sand.
78–81 Balls of stratified peat and sand, contortions, faulting.
81–84 Blue-grey and brown massive peaty silty sand, becoming clayey downward.
84–96 Massive, dark-brown to blue, silty clay.
96–108 Stratified peaty brown and blue silts. Incipient cream concretions.
108–154 Grey peaty clay with cream bands.
154–173 Slump to lake. Intermittent exposure of same clay.

A1004 — South of Lakehurst Drive

FOOTAGE
(upper part estimated)

0–30 Stratified sand and coarse gravel.
30–45 Dark clayey silt till with mica flakes.
45–75 Stratified sand. Upper 3 feet dense with brown clay bands.
75–135 Peaty clay.
135–165 Slump to lake.

A1004A — Wynnview Court

FOOTAGE

0–18 Fine buff silty sand with whorls.
18–20 Fine-to-coarse rounded gravel.
20–22 Medium stratified buff sand. Some black manganese stains.
22–25 Massive grey clay with mica flakes.
25–36 Clay till with mica flakes.
36– Stratified sand. *(Sand unit does not extend to level of Lake Ontario as shown in Figure 5 on Chart B.)*

A1007 — At Scarborough Water Works

FOOTAGE	
0–1	Dark soil and boulders.
1–2	Orange medium sand.
2–6	Buff contorted silt and clay.
6–18	Grey clayey silt till with few pebbles. In lower 5 feet occur large lenses of fine crossbedded dense sand and laminated clay.
18–36	Dark-grey silt till with few pebbles. Mica flakes.
36–38	Stratified sand and clay.
38–86	Fine yellow crossbedded sand. Current to south.
86–116	Grey stratified clay and peaty sand. Cream bands.
116–171	Slump to lake.

A1005 — At Fishleigh Drive

FOOTAGE	
0–2	Soil, yellow sand, and basal cobbles.
2–32	Laminated-to-varved silty clay. Lens of grey silty to sandy till rests on clays in part of section.
32–38	Contorted varved clay.
38–65	Grey varved silt and clay.
65–67	Buff fine silty sand and grey clay.
67–91	Grey varved clay. Varves vary from ½ inch to 6 inches in thickness. One giant varve 15 inches thick at 73 feet.
91–110	Sandy to silty, buff to dark-grey-brown, *till*. Upper 3½ feet buff with many silt balls overlying one or two thin varves; lower, it has inclusions and lenses of the dark phase predominating toward the base.
110–113	Laminated clay and fine crossbedded sand with plant detritus.
113–114	Crossbedded fine sand.
114–132	Stratified brown sand and clay with plant detritus.
132–144	Stratified silty and sandy clay.
144–151	Alternating massive and stratified beds of clay. Cream bands.
151–157	Massive silt bed.
157–181	Stratified clay with cream bands to lake level.

A1006 — Dutch Church Section. South end of Scarborough Crescent

FOOTAGE	
0–2	Stratified yellow sand and fine gravel. Thickens northward to about 10 feet in a shallow channel cut into the underlying clay.
2–92	Grey varved clay.
92–164	Grey silt till to lake. Just east of this, lenses of fine gravel 10 feet across occur in the till near the base. 800 feet east along shore, stratified sand and gravel occur to a thickness of 5 feet under the till.

A1008 — Amphitheatre Section. South of Chine Drive

FOOTAGE	
0–5	Alluvial sand and silt. Soil at top and base. Minor charcoal in lower soil.
5–6½	Gravel; rounded, medium at top, and fine at base.
6½–9½	Grey-buff stratified sand. Fine at top to coarse and pebbly at base.
9½–10	Hard buff clay.
10–86	Grey varved clay and silt. Upper 8 feet much contorted in part of section.
86–87	Interbedded silt till and varved clay. Many shale pebbles.
87–117	Grey massive silt till. Varved clay at 98 feet.
117–122	Peaty fine sandy clay and silt. Upper part contorted.
122–176	Slump to lake.

Supplementary Section just east of Amphitheatre Section (A1008)

FOOTAGE	
0–2	Dark-brown silt till, with mica flakes.
2–5	Fine crossbedded cream sand inclusions and brown till.
5–10	Brown clay and fine crossbedded sand.
10–12	Massive silt bed.
12–22	Peaty clay.
22–23	Contorted.
23–24	Massive silt bed.
24–30	Laminated clay.
30–32	Massive silt bed.
32–36	Laminated clay.
36–48	Laminated and massive silt and clay. Wood fairly abundant at 40 feet.
48–56	Slump to lake.

A1009 — Seminary Section. Southeast of St. Augustine's Seminary

FOOTAGE	
0–10	Buff sandy silt till.
10–14	Contorted till, sand, and clay.
14–27	Grey silt till.
27–32	Thin-varved (⅛ to ½ inch) grey silt and clay.
32–34	Dense buff silt.
34–42	Stratified fine crossbedded buff sand.
42–66	Contorted stratified grey-and-buff silt and fine sand. Subvarved in lower part.
66–78	Grey silty-to-sandy till. Moderately stony. Rises and thickens to the north at the expense of the overlying sand.
78–82	Stratified buff sand with garnet concentrations. Faulted.
82–84	Dense grey wet silt.
84–89	Dark-grey slickensided clay. Contorted in lower part.
89–108	Dark-grey silt till.
108–146	Stratified sand with peaty beds.
146–250	Stratified peaty clay to lake.

A1010 — Corner of Sunnypoint Crescent and Eastville Avenue

FOOTAGE	
0–13	Buff silt till. Very few pebbles.
13–26	Grey silt till. Silt balls.
26–26½	Grey thin-varved silt.
26½–29	Grey silt till.
29–31	Much-contorted varved silt.
31–34	Yellow and grey sand, and buff to yellow stratified silt.
34–58	Fine to medium buff stratified sand. Some silt at base. Contortions.
58–63	Grey dense wet silt. Contortions.
63–69	Dark-grey sandy silt till. Mica flakes.
69–91	Faulted crossbedded medium sand. Garnet-rich bands.
91–112	Dark grey silt till.
112–154	Stratified crossbedded creamy-pink sand. Current to south. Plant remains at 36 feet.
154–163	Massive silty sand.
163–173	Stratified cream sand and silty sand at base. Iron concretions.
173–251	Stratified clay and silt to lake.

A1011 — Sunnypoint Section. East of Sunnypoint Crescent

FOOTAGE	
0–2	Soil and decomposed sandy till.
2–10	Contorted stratified buff silt and dense sand. Some fine gravel. Many irregular concretions.
10–11	Buff silt till with few pebbles.
11–48	Grey clayey silt till with few pebbles.
48–52	Stratified clay and silt. Mild contortions.
52–71	Stratified fine cream sand and silty sand with strong contortions.
71–77	Grey dense silt. Contorted.
77–84	Grey silt till. Pebbles more abundant than till above.
84–92	Interbedded till and brown fine sand.
92–105	Fine crossbedded cream sand.
105–112	Medium-yellow stratified sand.
112–130	Grey silt till.
130–202	Peaty stratified sand.
202–280	Peaty clay to lake.

A1020 — Hi Section. At end of Scarborough Heights Boulevard

FOOTAGE	
0–16	Buff silty sand till.
16–18	Buff varved clay. Varves 1 inch thick at top to ¼ inch at bottom. Counted 90 varves. Faulted and contorted.
18–30	Crossbedded fine sand. Some contortion in top foot.
30–46	Varved clay. About 300 varves. Silty toward base. Some contortion.
46–64	Massive-to-laminated grey silt grading downward into fine sand. Large contortions in lower part.
64–65	Grey varved clay. Counted about 45 varves, varying from ½ to ¼ inch in thickness.
65–101	Dark-grey silty clay till. One foot of varved clay 2 feet from base; counted 20 varves ⅛ to ½ inch thick.
101–106	Grey-buff dense contorted sandy silt.
106–109	Stratified buff fine sand.
109–110	Sand with pebbles.
110–139	Dense fine sand. Contorted in upper part.
139–144	Dark clay till. Many silt balls. In part, interbedded with varved clay; counted about 20 varves ¼ to ¾ inch thick.
144–151	Grey sandy silt till.
151–170	Yellow crossbedded medium sand.
170–192	Grey silt till.
192–247	Orange sand with some plant detritus. Large contortions at 240 feet.
247–334	Peaty clay to lake.

A1014 — Cudia Park Section. West end of Cudia Park

FOOTAGE	
0–5	Weathered brown silty clay till with few pebbles.
5–6	Brown thin-varved clay.
6–8	Brown silty clay till.
8–11	Poorly-stratified reworked silt and clay. Basal foot contorted, cemented sand.
11–14	Crossbedded fine silty sand with gravelly seams.
14–15	Stony silt till with boulders. Some cementation.
15–51	Creamy-pink crossbedded medium sand.
51–75	Pink-buff, then orange-buff, crossbedded medium sand. Current to south. Heavy mineral concentrations.
75–96	Clay till, becoming silty toward base. Thickness varies because of pinnacles and troughs in upper surface but base quite level.
96–162	Crossbedded buff medium sand. Wood (rotten and mouldy) and shells at 126 feet.
162–246	Grey laminated peaty silt and clay to lake.

Supplementary Section from top of Iroquois Terrace

FOOTAGE	
0–3	Gravelly weathered soil. Calcareous below 2 feet.
3–4	Calcareous silt with molluscs and charcoal.
4–5	Silt and gyttja.
5–18	Colluvium from Iroquois bluff. Substratified silt and sand, containing blocks of till and randomly-oriented blocks of varved clay (varves are ½ inch thick and originate from below uppermost Wisconsinan till). Stratification improves southward away from Iroquois shorecliff.
18–22	Fine rounded beach gravel with some imbrication.

A1012 — West of Meadowcliffe Drive

FOOTAGE	
0–12	Buff silt till with few pebbles. Basal foot grey at north end of section.
12–13	Grey and brown thin-varved clay and silt (⅛ to ¼ inch thick).
13–16	Reworked varved clay and substratified brown silts. Two-inch concretionary sand layer at base.
16–20	Crossbedded fine sand. Some silt.
20–22	Kamy brown sand and gravel.
22–23	Brown sandy silty till. One inch of hard cemented sand at base.
23–25	Fine brown gravel.
25–57	Slump and fill to outer edge of Lake Iroquois Terrace.
57–74	Stratified silt and sand, probably alluvial.
74–84	Stratified medium-to-coarse yellow sand.
84–86	Silty fine grey-buff contorted sand.
86–106	Dark-grey silt till with mica flakes. Six-inch brown sand layer at 82 feet.
106–148	Buff crossbedded medium peaty sand. Current to the south.
148–235	Laminated peaty clay to lake.

A1015 — South of Meadowcliffe Drive

FOOTAGE	
0–10	Stratified silt and clay. Upper 2 feet black soil with shells.
10–13	Stratified buff silt and fine sand. Basal 1 foot sand and gravel.
13–27	Stratified silt and sand.
27–52	Dark clay till. Upper surface irregular, with lenses of stratified hard buff silt up to 2 feet thick resting in hollows; small pebbles of the till in bands in the silt.
52–96	Buff fine-to-medium stratified crossbedded sand. Current to south. Shells at 82 feet.
96–187	Dense sand and silt, grading downward to clay with peat to lake.

A1013 — Ravine at east end of Meadowcliffe Drive

FOOTAGE	
0–23	Buff sandy silt to silty sand till. Abundant shale pebbles. Three-foot sand lens at 10 feet.
23–24	Massive grey-brown clay.
24–26	Brown varved clay (mostly ½-inch layers).
26–28	Massive and varved grey clay.
28–32	Stratified yellow-and-buff silty sand.
32–34	Grey wet silt.
34–69	Transferred to west side of valley from east side. Silt till with few pebbles.
69–71	Thin-varved clay and silt.

A1013 (cont'd)

71–77 Buff stratified silt and fine sand. Contorted in part.
77–81 Stratified buff silty fine sand and medium sand. Contorted in upper 2 feet.
81–83 Buff silt till.
83–95 Grey silt till.
95–107 Interbedded silt till and fine silty sand in beds 10 inches thick. Oxidized in lower 2 feet.
107–113 Interbedded pebbly sand and buff sandy till.
113–149 Stratified buff fine sand. Faulted and contorted. Some thin silt bands. Bottom 12 feet of uniform stratified contorted fine sand.
149– Clay till. Transferred section south 100 yards.

From top of Iroquois Terrace, overlapping previous section

FOOTAGE
0–6 Brown stratified silt, grading down to fine gravel and sand.
6–17 Stratified buff silt and sand.
17–22 Poorly-sorted silty medium gravel. Some cobbles and boulders at base. Unconformity at base.
22–37 Light-grey uniform compact stratified silty sand, water-saturated at base. Contorted and faulted. Thin film of plant detritus 3 feet from base.
37–59 Dark-grey silt till. Substratified in upper part.
59–103 Stratified pink-orange sands. Peaty silt at 68 feet and at 89 feet. Scattered plant detritus throughout. Contortions at 97 feet. Current to south. Some limonite concretions at 94 feet.
103–116 Grey stratified silt and sand with peat.
116–118 Massive silt bed.
118–185 Laminated silt and peaty clay to lake.

A1016 — South of Sylvan Avenue and west of Heathfield Drive

FOOTAGE
0–4 Stratified buff-and-brown silt and sand.
4–10 Stratified buff medium sand. Coarse sand and medium gravel in basal 1 foot.
10–23 Stratified crossbedded cream fine sand. Contorted.
23–45 Dark silt till with mica flakes.
45–52 Stratified silty fine sand.
52–78 Stratified buff medium sand. Shell fragments and peat at base.
78–84 Contorted fine silty sand.
84–88 Crossbedded brown sand. Current to south.
88–178 Grey sandy silt and peaty clay. Lake Ontario level.

A1017 — South of Sylvan Avenue and west of Bethune Boulevard

FOOTAGE
0–2 Soil and boulders.
2–9 Stratified fine sand. Upper 2 feet contorted. Peaty layers in lower foot.
9–11 Contorted clay till and silt and sand.
11–38 Dark clay till. Upper surface irregular.
38–44 Disturbed yellow sand and dark-grey silt.
44–96 Stratified sand.
96–184 Peaty silt and clay to lake.

A1018 — Minor headland east of east end of Sylvan Avenue

FOOTAGE
0–61 Dark silt till. Moderately stony in upper part.
61–69 Poorly exposed interbedded peaty sand and till. Contorted in lower part.
69–83 Dense massive peaty sandy silt. Vague contortions.
83–91 Stratified peaty sand and clay.
91–103 Massive silt.
103–110 Stratified peaty silt and clay.
110–116 Massive silt.
116–128 Stratified peaty silt and clay.
128–157 Slump to lake.

A1019 — At Livingston Road

FOOTAGE
0–40 Dark-grey silt till.
40–54 West side: stratified fine grey sand and till. East side: silt till and a 3-foot bed of contorted sand.
54–64 Channel fill of fine stratified sand with crossbedded peat and shell fragments. On east side: 5 feet of black fine gravel; on west side: wedge of gravel thickens from zero to 3 feet to north as base becomes lower.
54–78 Channel cuts out interbedded fine brown crossbedded sand and contorted silty sand with plant detritus.
78–96 Massive bed of dense silty sand. Irregular top has sand beds draped in hollows.
96–161 Stratified peaty silt and clay.

A1021 — Between Livingston Road and Guild Inn

FOOTAGE
0–46 Grey silt till.
46–77 Badly slumped but noted basal contact of till and sand.
77–84 Brown medium peaty sand.
84–88 Massive brown silt bed.
88–90 Brown stratified sand.
90–120 Silty sand.
120–167 Peaty clays, silts, and minor sands to lake.

A1022 — Guild Inn section

FOOTAGE
0–34 Silt till. Long lenses up to 1 foot thick of fine gravel in lower part of till. Till truncates bedding of underlying sand; contact rises to north at small angle.
34–95 Stratified buff fine sand and brown peaty sand. Contortions between 40 and 50 feet. Peat and wood and shells at 61 feet.
95–174 Peaty silt and clay to lake.

A1023 — At Poplar Road

FOOTAGE
0–6 Stony sandy buff till.
6–36 Grey silt till. Sand lenses in lower 2 feet.
36–44 Stratified fine sand and silty sand with plant detritus.
44–74 Massive-to-stratified silt and sand. Contorted.
74–157 Grey peaty silt and clay to lake.

A1024 — At Morningside Avenue

FOOTAGE	
0–8	Stratified buff fine sand.
8–9	Stratified gravelly sand.
9–16	Grey silty sand till. Moderately stony.
16–28	Brown and buff peaty sand.
28–119	Laminated peaty clay to lake.

A1025 — East of Cushenden Road

FOOTAGE	
0–12	Silty sandy moderately-stony till; oxidized to 6 feet.
12–13	Brown silty sand.
13–30	Yellow-to-buff medium sand with peaty layers.
30–128	Gray silty sand with peat, grading down into clay to lake.

A1026 — East of A1025, ¼ mile

FOOTAGE	
0–3	Weathered sandy till.
3–10	Stratified sand.
10–88	Stratified clay and silt to lake.

A1027 — East of Manse Road

FOOTAGE	
0–3	Silty fine buff-to-yellow stratified sand and soil.
3–6	Buff silty-sandy till.
6–16	Grey silty sand till. Some thin sand stringers.
16–32	Brown medium stratified sand with plant detritus; silty in lower part.
32–93	Stratified silt, some sandy, and clay to lake.

A1028 — Three-quarters of a mile west of Beechgrove Drive

FOOTAGE	
0–4	Rudely stratified buff silt.
4–10	Grey massive silt; some stones in lower part.
10–20	Grey silty sandy stony till. Upper contact quite irregular. Softer and sandier in basal part.
20–30	Interbedded grey-buff sandy till and poorly sorted sand and silt.
30–48	Contorted grey silt and buff fine sand.
48–60	Grey substratified sandy till.
60–72	Grey shale-rich fine-to-coarse gravel.
72–78	Slump to lake.

A short distance west of A1028, plant-bearing Scarborough Formation outcrops to a height of 35 or 40 feet above the lake. Between A1028 and A1029, a complex of substratified stony till and kamy sand and gravel, all much contorted into striking folds, constitutes the entire height of the cliffs. All these materials seem related to the Leaside Till. Much of this material resembles a flow-till.

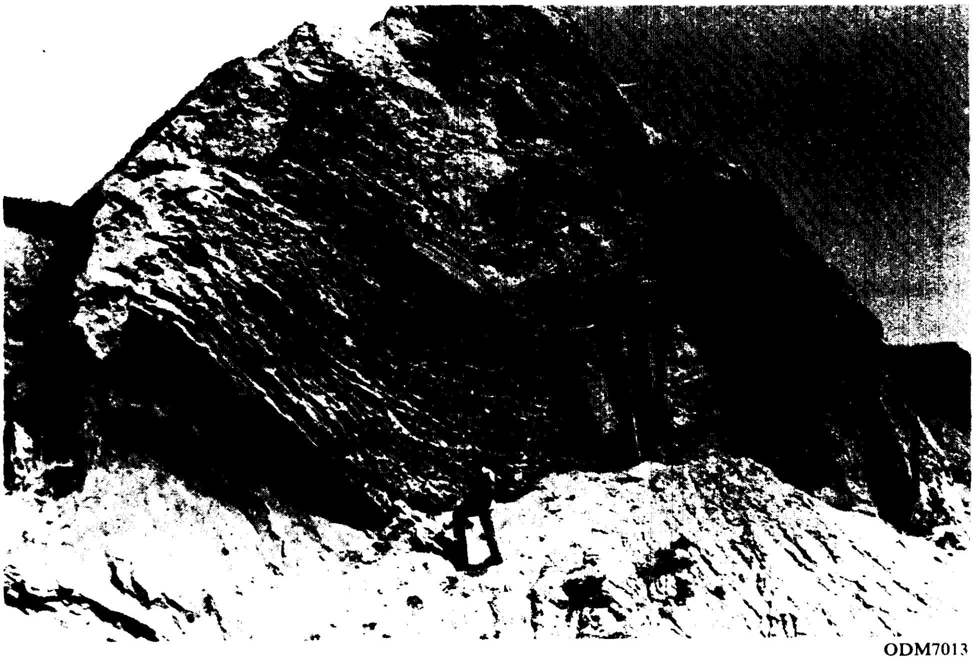

Photo 14—Contorted stratification in Leaside Till near Beechgrove Drive at Scarborough Bluffs.

A1029 — Half a mile west of Beechgrove Drive

FOOTAGE
0–5 Faintly stratified buff silt and clay.
5–14 Grey silty sandy stony till.
14–66 Slump to lake. Upper 10 feet shows some interstadial stratified sand and silt.

A1030 — Prominent headland west of Beechgrove Drive

FOOTAGE
0–24 Sandy silty stony till. Many water-bearing sand lenses. Becomes siltier downward. Blocks of Scarborough silt appear some places.
24–50 Slump to lake.

A1031 — East of Beechgrove Drive

FOOTAGE
0–6 Fine sand over brown subvarved conglomeratic clay.
6–40 Sandy stony till.

A1032 — West of Mouth of Highland Creek

FOOTAGE
0–9 Sandy stony till with numerous water-bearing sand lenses. Grey in lower two feet, buff above.
9–37 Brown Scarborough silts and clays to lake.

MASSEY CREEK SECTIONS

B260

FOOTAGE

0–18 Buff sandy till. Hard and compact.
18–29 Buff stratified fine sand. Pockets of silty sand and till. Occasional pebbles. Minor contortions.
29–35 Brown sandy till.
35–39 Brown iron-stained fine stratified sand.
39–43 Light-brown contorted stratified fine sand with iron stains.
43–48 Interbedded fine white sand and grey silty sand. Some pebbles.
48–52 Grey silty sand till.
52–56 Light-grey faintly-stratified silty sand with a few pebbles.
56–62 Blue-grey stratified sandy silt with a few pebbles.
62–65 Slump to creek.

B261

FOOTAGE

0–35 Buff silty sand till.
35–36 White stratified sand.
36–40 Grey-buff silty sand till. Harder than above till.
40–42 Light-buff iron-stained stratified medium sand.
42–59 Dense grey stratified contorted silty sand. Creek level.

B262

FOOTAGE

0–26 Buff sandy silt till. Abundant shale pebbles.
26–28 Grey silt till. Cobble concentration at base. Striae 130°.
28–32 Grey sand till.
32–44 Grey sandy silt till.
44–64 Slump to creek.

B263

FOOTAGE

0–35 Light-grey stratified contorted sandy silt to silty sand. Beds up to 1 inch thick. Occasional pebbles.

B264

FOOTAGE

0–10 Buff sandy silt till.
10–12 Buff massive fine sand. Iron stains at base.
12–38 Light-grey stratified silty sand to sandy silt. Beds average ¼-inch thick. Resemble varves. Creek level.

B265

FOOTAGE

0–25 Light-grey to grey-blue, stratified or varved, silty sand to sandy silt. Beds average ¼-inch thick. Faulted.
25–33 Dark-grey silt till. Low in pebbles. Contains silt balls and remanent stratification.

B266

FOOTAGE

0–19	Dark-grey silt till. Low in pebbles. Some brown sand lenses within the till.
19–32	Slump to creek; 100 yards downstream, stratified peaty clay observed under the dark-grey stone-free till.

WEST BRANCH, HIGHLAND CREEK

C157

FOOTAGE

0–7	Soft sandy buff till; few pebbles.
7–11	Stratified pebbly kame sand.
11–17	Contorted stratified medium-to-fine sand. Thin lenses of fine gravel.
17–23	Slumped till and sand.
23–28	Medium sand and fine gravel.
28–33	Interbedded fine sand and buff silty sandy till.
33–35	Stratified buff silty sand.
35–43	Silt till and contorted stratified silt. Few pebbles. Grey.

C156

FOOTAGE

0–3	Sandy till-like colluvium.
3–7	Stratified crossbedded sand. Fine at top, coarse at base.
7–11	Buff sandy till. Hard at top, soft at bottom.
11–13	Stratified dirty fine gravel and silty sand. Aquifer.
13–27	Buff silty sand till.
27–33	Kamy sand, gravel, and till.
33–35	Grey silty sand till.
35–48	Contorted reworked clay and silt.
48–56	Mostly slump. Contorted clay at base. Creek level.

C154

FOOTAGE

0–5	Substratified loose sandy till.
5–6	Stratified medium sand and silty sand.
6–14	Slump.
14–24	Dense grey-buff very-sandy till. Black shale. Pebbles.
24–30	Stratified contorted medium-dense sand with layers of same till as above. Transfer section 200 feet downstream.
30–44	Varved-to-laminated grey clay and silt. Flat-lying beds alternate with contorted beds at up to 3-foot intervals. Bedding thickens towards base to 4 inches.
44–56	Slump to creek. Probably all silt and clay.

C153

Footage	
0–5	Soil and roots.
5–15	Kamy stratified sand, silty sand, and sandy till.
15–17	Grey silty sand till.
17–27	Contorted buff interbedded sand, silty sand, clay bands, and till. Kamy gravelly sand, partly cemented, at top.
27–35	Silt till with contorted varves near base.
35–41	Slump.
41–47	Grey silt till with few pebbles. Thin dikes and lenses of medium sand. Lower foot oxidized.
47–53	Yellow and buff stratified sand. Crossbedded in lower part and contorted in upper part.
53–59	Grey clay-silt till with few pebbles. To creek level.

C158

Footage	
0–14	Grey silty sand till.
14–16	Stratified fine subrounded gravel over sand.
16–22	Grey stony sand till.
22–42	Slump. Possibly fine silt and sand.
42–52	Black clay till. Smell of peat. Pebble-free.

C159

Footage	
0–25	Stratified medium-to-fine silty buff sand. Faulted and contorted in part.
25–44	Black silty clay till with few pebbles.
44–45	Contorted peaty clay and silt with abundant mica.

C161

Footage	
0–15	Dark-grey clayey silt till. Stone-free.
15–16	Same till but brown and sandier.
16–17	Loose medium sand.
17–23	Slump to creek.

C164

Footage	
0–5	Buff sandy till.
5–12	Massive to stratified medium buff sand. Laminated silt and sand at base.
12–14	Grey sandy till.
14–17	Stratified medium buff sand.
17–19	Grey sandy till.
19–20	Stratified buff medium sand interbedded with grey silt and clay.
20–22	Dark-grey to black silty clay till with few pebbles.
22–37	Interbedded lenses of buff medium sand, fine sandy till, and black clay till.

C162

Footage	
0–15	Sandy buff till.
15–36	Fine well-sorted stratified sand. Till lenses contorted into upper foot. Faulted and mildly contorted.
36–47	Blocky dark-grey clay till.
47–75	Slump to creek.

C163

FOOTAGE	
0–16	Stratified contorted fine sand. Lower 2 feet interbedded with laminated silt.
16–17	Grey sandy silt till
17–19	Brown medium-to-coarse sand and fine gravel. Thickens to north to 4 feet and includes bed of boulders.
19–37	Nearly-stonefree dark-grey clay till.
37–39	Pink and orange medium loose sand.
39–65	Slump to creek.

C165

FOOTAGE	
0–2	Fine yellow sand.
2–17	Buff sandy till. Thin sand stringers.
17–18	Substratified till and sand. Break in slope.
18–20	Grey sandy till.
20–23	Grey sandy silt till.
23–30	Dark-grey silt till. Few pebbles. Lenses out to east and west.
30–51	Stratified fine light-grey sand.
51–54	Clay balls and bands in same sand.
54–76	Dark-grey to brown-black silt till. Reworked stratified silt and clay in upper part.
76–79	Disturbed stratified medium sand and clay bands.
79–97	Stratified medium crossbedded sand. Current to west. Few shells and possible peat.
97–103	Slump to creek.

C225

FOOTAGE	
0–10	Buff slightly-sandy silt till with few pebbles.
10–11	Stratified buff sand.
11–37	Grey clayey silt till with few pebbles.
37–71	Stratified orange sand. Crossbedding indicates current to south. Heavy mineral concentrations.
71–80	Slump to creek.

MAIN BRANCH, HIGHLAND CREEK

D145

FOOTAGE	
0–8	Buff stratified silty clay. Layers ¼-inch thick.
8–10	Stratified fine buff sand.
10–16	Grey silty sand till.
16–42	Dark-grey sandy silt till. Creek level.

D146

FOOTAGE	
0–14	Loose buff sandy till.
14–40	Dark-grey-buff slightly clayey silt till. Few pebbles.
40–54	Slump to creek.

D147

FOOTAGE	
0–2	Soil.
2–14	Buff silt till with very few stones.
14–16	Dark grey-buff clay with poor stratification.
16–22	Grey silty sand.
22–24	Slump to creek.

D148

FOOTAGE	
0–18	Buff sandy till, fairly pebbly.
18–24	Dark-grey silt till with few pebbles.
24–32	Fine buff sand, siltier toward base.
32–67	Slump to creek.

D149

FOOTAGE	
0–14	Buff hard sand till; fairly pebbly.
14–15	White fine sand.
15–19	Till as above.
19–21	Coarse sand and medium gravel, poorly sorted.
21–24	Buff-to-grey silt till with few pebbles.
24–34	Stratified fine sand. Slightly contorted.
34–56	Stratified fine-to-silty buff sand. Contorted. Heavy mineral concentrations.
56–81	Slump to creek.

D200

FOOTAGE	
0–29	Buff silty sand till. Some sand lenses.
29–47	Slump. Transferred section.
47–77	Stratified buff-to-grey fine sand. Creek level.

D201

FOOTAGE	
0–10	Buff sandy till.
10–20	Dark-grey sandy silt till. Pebbles rare.
20–24	Grey stratified silty sand. Contorted.
24–48	Slump to creek.

D202

FOOTAGE	
0–2	Soil.
2–16	Buff sandy till.
16–79	Slump to creek.

D203

FOOTAGE	
0–8	Buff sandy till.
8–23	Grey hard sandy till.
23–31	Slump to creek.

D204

Footage	
0–2	Alluvial gravel.
2–8	Stratified buff sand.
8–15	Buff clayey silt. Few pebbles and slight stratification.
15–22	As above but grey. Creek level.

D205

Footage	
0–2	Soil.
2–10	Buff slightly sandy silt till with few pebbles.
10–20	Dark-grey silt till. Patches of remanent stratification.
20–42	Poorly exposed; interbedded buff silty sand and white sand.
42–78	Slump to creek.

D208

Footage	
0–2	Soil.
2–6	Poorly sorted gravel.
6–8	Slump to creek. Nearby exposure of dark-grey silt till.

D209

Footage	
0–11	Buff sandy silt with few pebbles.
11–43	Grey sandy silt with reworked stratification. Few pebbles.
43–49	Slump to creek.

D210

Footage	
0–7	Coarse sand and gravel.
7–25	Buff silty sand-till.
25–27	Buff silty sand.
27–29	Buff silty sand-till.
29–41	Grey sandy silt with few pebbles. Same as D209.
41–83	Slump to creek.

D211

Footage	
0–2	Yellow sand.
2–12	Fine-to-medium sandy gravel.
12–16	Dark-grey clayey silt till.
16–19	Slump to creek.

D212

Footage	
0–16	Medium subangular gravel.
16–22	Slump to creek.

D213

FOOTAGE

0–19	Buff sandy silt till. Few pebbles.
19–24	Grey till as above.
24–30	Grey silty sand. Few pebbles.
30–32	Buff medium stratified sand.
32–38	Dark-grey clayey silt till with few pebbles.
38–85	Slump to creek.

D214

FOOTAGE

0–2	Buff silty till with few pebbles.
2–41	Pink-buff to orange fine-to-silty stratified sand. Heavy mineral concentrations. Peaty layers. Slightly contorted and faulted in lower part which may be partly slumped.
41–45	Slump to creek.

D224

FOOTAGE

0–2	Sandy and gravelly soil.
2–21	Buff coarse stratified sand. Silty at base.
21–26	Buff clayey sand till. Abundant shale pebbles.
26–63	Grey-buff clayey silt till with few pebbles. Separated from till above by thin layer of stratified sand. Lower contact dips down to 69 feet downstream — section transferred.
69–75	Buff medium stratified sand. Lenses of silt till near base.
75–86	Dark-grey silty clay till, nearly stone-free.
86–117	Stratified orange-to-white fine sand. Minor contortion and faulting.
117–118	Slump to creek.

D226

FOOTAGE

0–2	Sandy soil.
2–5	Weathered clayey sand till.
5–50	Grey-buff clayey silt till with very few pebbles.
50–53	Very sandy substratified till. Transfer section downstream 100 feet.
53–84	Stratified buff silty sand. Heavy mineral concentrations.
84–93	Slump to creek.

D167

FOOTAGE

0–2	Sandy soil.
2–14	Buff fine sandy till with few pebbles.
14–17	Same till interbedded with orange stratified sand.
17–84	Same till but grey and finer to base.
84–128	Slump to creek.

Scarborough area

D44

FOOTAGE	
0–21	Stratified fine-to-medium gravel and sand. Well rounded. Springs at base
21–46	Sandy silty till. Finer and less stony downward.
46–52	Slump.
52–67	Silt till with few pebbles; same as base of till above.
67–82	Fine sand till with whorls of fine sand and slight stratification.
82–101	Crossbedded stratified fine silty sand. Contorted in upper part.
101–103	Clay-silt till with few pebbles.
103–109	Orange medium sand. Silt beds near bottom.
109–123	Slump.
123–129	Grey, mostly massive, dense silty sand with plant fragments.

D170

FOOTAGE	
0–16	Brown pebble-free silt till.
16–19	Interbedded grey fine sandy till and yellow silty sand. Pebble-free.
19–21	Dark-gray silt till; pebble-free. Remanent stratification.
21–67	Stratified crossbedded fine sand. Some contortion. Peaty layers.
67–70	Stratified silt, clay, and sand.
70–72	Slump to river.

D235

FOOTAGE	
0–2	Soil.
2–4	Coarse sand and medium gravel.
4–10	Buff stratified fine sand.
10–18	Grey silty sand till.
18–57	Slump.
57–81	Stratified crossbedded fine sand.
81–104	Slump to creek.

D171 — Road cut on Morningside Drive

FOOTAGE	
0–12	Stratified sand and gravel; fine to medium and well-rounded.
12–18	Grey silty sand till. Moderately stony.
18–19	Grey substratified sandy till.
19–33	Grey silt till with few pebbles. Contorted remanent stratification.
33–113	Slump to river.

LOWER HIGHLAND CREEK

E236

FOOTAGE
0–5 Alluvial gravel with logs.
5–9 Dark-grey silt till with few pebbles. Creek level.

E237

FOOTAGE
0–6 Alluvial gravel and sand.
6–12 Stratified buff fine sand. Upper contact erosional. Creek level.

E238

FOOTAGE
0–10 Buff sand.
10–14 Alluvial gravel.
14–26 Dark-grey slightly-sandy silt till. Creek level.

E239

FOOTAGE
0–9 Buff sandy silt till. A 6-foot band of gravel 1 foot thick.
9–66 Dark-grey slightly-clayey silt till. Creek level.

E240

FOOTAGE
0–7 Stratified buff gravelly sand.
7–29 Dark-grey clayey silt till with silt balls. Creek level.

E241

FOOTAGE
0–4 Brown fine sand. Six inches of buff silt at base.
4–7 Grey stratified contorted medium sand.
7–16 Grey sandy silt till.
16–52 Slump.
52–94 Grey sandy silt till grading to clayey silt till below 72 feet.
94–99 Grey silty sand till with more abundant pebbles.
99–103 Slump to creek.

E242

FOOTAGE
0–5 Buff fine sand with minor medium gravel.
5–9 Stratified contorted grey-buff fine sand.
9–32 Micaceous sandy silt till; stoniness increases moderately downward.
32–44 Slump.
44–115 Dark-grey silt till with few pebbles. Some silt balls and remanent stratification.

E244

Footage	
0–3	Weathered sandy till.
3–11	Buff slightly-silty sand till.
11–24	Grey slightly-silty sand till.
24–35	Coarse sand and medium gravel, coarser downward.
35–109	Dark-grey silt till, less stony than above. Creek level.

E243

Footage	
0–10	Buff sandy silt till with few pebbles.
10–28	Grey-buff sandy silt till.
28–42	Slump to creek.

E245

Footage	
0–8	Grey-buff slightly-silty sand till.
8–14	Buff contorted stratified sandy silt.
14–18	Buff-to-orange contorted coarse sand.
18–21	Grey sandy till with few pebbles.
21–23	Grey coarse sand.
23–38	Grey stony hard sandy till. Siltier to base.
38–39	Till as before but substratified.
39–69	Grey-to-black silt till with few pebbles.
69–74	Interbedded silt, sand, and gravel.
74–78	Buff sandy silt till with few pebbles.
78–80	Buff micaceous hard silt till.
80–82	Slump to creek.

WEST TRIBUTARY OF ROUGE RIVER

G123

Footage	
0–2	Alluvial sand and gravel.
2–7	Buff sandy till.
7–8	Grey silt till. Creek level.

G124

Footage	
0–38	Buff silty sand till; finer downward, micaceous, with few pebbles. Some sand seams and lenses.
38–40	Partially-cemented rounded sand and gravel.
40–46	Stratified fine buff sand.
46–47	Partially cemented sand and gravel.
47–53	Dark-grey stratified silty sand. Creek level.

G126

FOOTAGE

0–16 Buff silty sand till; pebble content low.
16–43 Slump to creek. At creek, same till but grey.

G127

FOOTAGE

0–2 Soil.
2–4 Buff sandy till, boulder concentration at base.
4–17 Substratified-to-massive buff sandy till.
17–25 Grey slightly-silty sandy till.
25–48 Slump to creek. At creek same till as above.

G129

FOOTAGE

0–2 Soil.
2–13 Stratified medium buff sand.
13–16 Same sand with clay layers.
16–17 Buff sandy till with few pebbles.
17–22 Grey-buff stratified silty sand.
22–25 Interbedded buff sandy till and stratified silty sand.
25–28 Buff sandy till. Basal layer of sand.
28–30 Grey-buff sand till.
30–38 Grey silty sand till.
38–70 Slump to creek.

G128

FOOTAGE

0–3 Substratified sandy till.
3–4 Buff silty sand.
4–16 Grey sandy silt till.
16–17 Laminated clay and silt.
17–24 Dark-grey sandy silt till. Creek level.

G130

FOOTAGE

0–4 Stratified clay and silty sand.
4–10 Substratified buff silty sand till. Occasional clay layer.
10–22 Buff silty sand till with few pebbles.
22–25 Interbedded till, clay, coarse sand, and fine gravel.
25–26 Grey-buff silty sand till.
26–36 Slump. Transfer section across creek.
36–39 Terrace gravel.
39–41 Dark-grey silt till.
41–43 Stratified medium orange sand with peat. Scarborough Formation. Creek level.

G131

FOOTAGE

0–2 Clayey sand soil.
2–3 Alluvial boulder gravel.
3–6 Buff clayey sand till.
6–15 Dark-grey clayey sand till.
15–28 Dark-grey sandy silt till with few pebbles. Creek level.

G132

FOOTAGE	
0–5	Buff stratified silty sand.
5–7	Partially cemented sand and gravel.
7–16	Buff sandy till.
16–20	Stratified fine-to-coarse sand. Boulders at base.
20–85	Dark-grey sandy silt till.
85–111	Slump to creek.

G57

FOOTAGE	
0–3	Medium-to-coarse terrace gravel.
3–8	Dark-grey silty clay till; pebble-free.
8–13	Stratified brown clayey silt and silty sand.
13–18	Grey stratified peaty clay and yellow sand.
18–28	Stratified, peaty, and silty sand.
28–34	Grey-brown interbedded silty fine sand and peaty sand.
34–40	Slump to creek.

ROUGE RIVER

F8

FOOTAGE	
0–11	Buff sandy till.
11–36	Grey hard sandy till.
36–38	Same till with sand pockets.
38–40	Poorly-sorted subangular sand and gravel.
40–50	Fine stratified silty sand. Contorted.
50–53	Slump to river.

F9 — Edge of golf course beside C.P.R.

FOOTAGE	
0–8	Sandy buff till.
8–18	Stratified crossbedded sand and minor fine gravel.
18–40	Slump. Small bog nearby to northwest with up to 10 feet of muck, peat, and marl.

F6

FOOTAGE	
0–11	Stratified silty clay, reddish in lower foot. Grades down into varves at base.
11–15	Brown substratified sandy till.
15–29	Grey sandy till. River level.

F5

Footage	
0–18	Hard buff sandy till.
18–24	Grey, same till.
24–38	Laminated silt and clay.
38–42	Slump to river. River bed in stratified silt.

F7

Footage	
0–23	Brown sandy till. Patches of grey till. Sand lenses.
23–43	Slump to river.

F16

0–9	Buff sandy till.
9–14	Stratified sand and fine gravel. Coarse gravel in lower foot.
14–35	Grey sandy stony till.
35–37	Poorly-sorted silty sandy gravel.
37–47	Grey silt till. River level.

F19

Footage	
0–11	Buff sandy till.
11–13	Stratified medium buff sand.
13–15	Hard buff sandy till.
15–21	Stratified medium buff sand and fine gravel.
21–24	Medium-to-coarse subrounded gravel.
24–36	Grey and buff sandy till.
36–54	Slump to river.

F18

Footage	
0–12	Brown sandy stony till.
12–15	Buff stratified sand and silt.
15–19	Buff sandy stony till with sand lenses.
19–23	Stratified poorly-sorted medium sand and gravel.
23–27	Buff sandy stony till with sand lenses.
27–28	Sand and boulders.
28–41	Buff sandy stony till.
41–56	Partly slump. Soft grey sandy till.

F17

Footage	
0–7	Stratified fine silty buff sand grading down into thin-varved, reddish silt and clay.
7–10	Substratified soft sandy till.
10–23	Grey sandy till with sand lenses.
23–29	Grey sandy stony till.
29–54	Slump to river.

F20

Footage	
0–13	Buff sandy till. Interbedded with sand at base.
13–19	Dense buff stratified silty sand.
19–27	Stratified buff-and-yellow fine silty sand.
27–30	Dark-grey clay grading into till in places.
30–34	Contorted light-grey silty sand.
34–57	Slump to river.

F21

Footage	
0–2	Terrace sand and gravel.
2–10	Sand and gravel.
10–11	Slump. Probably sand.
11–14	Grey stratified fine sand.
14–30	Slump. Probably sand.
30–31	Grey stratified sand.
31–39	Contorted grey silty clay.

F246

Footage	
0–2	Gravelly soil.
2–4	Kamy sand and gravel; sandy stony till.
4–11	Silty sandy till.
11–13	Kamy sand and fine gravel.
13–19	Stratified kamy sand and silty sand.
19–21	Hard silty sandy till; buff.
21–60	Grey sandy till substratified and interbedded with silty sand at base.
60–62	Grey-and-buff hard sandy till.
62–78	Stratified fine silty sand. Contortions.
78–81	Slump.
81–90	Grey silty clay till with few pebbles. River level.

F113

Footage	
0–6	Buff sandy till.
6–11	Dark-grey micaceous slightly-sandy silt till.
11–15	Brown fine sand.
15–21	Dark-grey micaceous silt till with few pebbles.
21–25	Buff-and-grey silty sand till with few pebbles.
25–37	Slump to river; contorted silt at river.

F22

Footage	
0–2	Soil.
2–7	Buff clayey-silt till, stratified in places, with few pebbles.
7–33	Grey clayey silt till with few pebbles.
33–51	Slump to river; till is sandier at river.

F23

FOOTAGE	
0–4	Slump and soil.
4–6	Buff disturbed varved clay and silt.
6–10	Buff substratified sandy till. Thin clay bands.
10–13	Grey stratified-to-varved clay and silt.
13–37	Slump. Transferred section downstream.
37–48	Grey clayey silt till, with few pebbles.
48–50	Stratified clay and silt.
50–54	Same till as above.
54–64	Slump to river. Same till at river level.

F110

FOOTAGE	
0–18	Buff sandy till.
18–39	Grey sandy till with abundant pebbles.
39–45	Grey massive silty clay with silt balls.
45–61	Possibly slump. Grey massive sandy silt with few pebbles.
61–82	Dark-grey micaceous silt till.
82–94	Buff stratified fine sand.
94–112	Slump to river.

F111

FOOTAGE	
0–5	Stratified fine-to-coarse gravel and sand.
5–8	Boulder gravel.
8–16	Dense buff silty sand.
16–18	Grey stratified silty sand; occasional pebbles.
18–47	Dark-grey micaceous massive clayey silt. Till(?). River level.

F112

FOOTAGE	
0–25	Buff sandy till. Upper 6 foot substratified.
25–28	Stratified fine buff sand.
28–31	Grey-buff sandy silt with occasional pebble; substratified.
31–36	Same as above, but green in color.
36–80	Slump to river. At river level, dark-grey clayey silt.

F114

FOOTAGE	
0–2	Buff alluvial sand with shells.
2–6	Boulder gravel.
6–13	Light-grey stratified sand.
13–31	Dark-grey micaceous clayey silt till.
31–43	Stratified sand (Scarborough Formation). River level.

F115

FOOTAGE	
0–10	Buff silt till.
10–25	Grey silt till.
25–37	Dark-grey silt till with few pebbles.
37–43	Stratified fine buff sand.
43–61	Buff stratified silty sand.
61–83	Slump to river.

Scarborough area

F116

FOOTAGE	
0–3	Stratified sand with shells. Boulders at base.
3–4	Buff silty sand till.
4–12	Dark-grey micaceous clayey silt till.
12–20	Buff stratified sand.
20–24	Grey stratified silty sand with peat.
24–25	Slump to river.

F117

FOOTAGE	
0–21	Buff sandy till.
21–87	Fine sandy silt till; mostly grey.
87–113	Stratified, contorted, and faulted coarse sand.
113–126	Grey dense stratified silty sand with occasional pebbles. Waterlaid till(?).
126–132	Rounded boulder gravels.
132–165	Slump to river.

F119

FOOTAGE	
0–8	Alluvial boulder gravel.
8–24	Dark-grey silt till with few pebbles and many silt balls.
24–42	Stratified fine sand with plant detritus.
42–50	Slump to river.

F120

FOOTAGE	
0–36	Buff silty sand till.
36–68	Grey sandy silt till.
68–72	Brown medium-to-silty sand with peaty beds.
72–93	Grey micaceous silt till with few pebbles. Some remanent stratification.
93–111	Stratified medium buff sand with minor peat.
111–127	Slump to river.

F133

FOOTAGE	
0–2	Gravelly soil.
2–6	Coarse sand and fine gravel.
6–12	Buff-to-orange stratified medium sand with peat.
12–33	Slump to river.

Scarborough area

F121

Footage	
0–3	Substratified buff sandy till.
3–13	Buff silty sand till. Lens of silt till 6 feet thick.
13–23	Grey silty sand till, clayier downward.
23–34	Interbedded clayey silt till and contorted varved clay.
34–39	Interbedded buff sand and clay; faulted.
39–40	Grey silty sand.
40–50	Buff sandy till, pebblier downward.
50–54	Coarse sand and fine gravel.
54–68	Dark-grey clayey silt till with few pebbles.
68–87	Stratified pink-to-orange sand. Wood fragments.
87–94	Interbedded fine sand and grey silt.
94–110	Slump to river.

F122

Footage	
0–6	Substratified buff clayey sand till.
6–8	Buff silty sand; occasional pebble.
8–35	Grey silty sand till.
35–37	Grey sandy gravelly till.
37–89	Dark-grey silt till with few pebbles. Remanent stratification.
89–113	Stratified pink-to-orange fine sand with peaty layers.
113–127	Dark-grey stratified peaty silt.
127–138	Slump to river.

F55

Footage	
0–6	Buff silty sand till.
6–27	Grey sandy silt till; micaceous.
27–52	Slump.
52–60	Stratified fine pink-buff peaty sand and silt. River level.

F58

Footage	
0–14	Buff sandy till.
14–50	Grey silty sand till. Thin sand bands at 38 feet.
50–51	Grey-buff stratified sand. Same till below.
51–111	Slump to river.

F136

Footage	
0–10	Alluvial boulder gravel.
10–28	Stratified grey clayey silt. River level.

F135

Footage	
0–2	Sandy soil.
2–16	Buff sandy till; not many pebbles.
16–50	Grey silty sand till.
50–71	Buff, orange, and brown medium-to-silty fine peaty sand.
71–97	Dark-grey-buff laminated clayey silt.
97–99	Blue and brown medium sand.
99–100	Weathered blue shale.

F134

FOOTAGE	
0–2	Sandy soil.
2–23	Stratified medium-to-fine silty peaty sand; buff, orange, and grey colour. Faulted and contorted.
23–39	Dark-grey stratified sandy silt.
39–43	Blue clayey silt. River level.

F138

FOOTAGE	
0–2	Gravelly soil.
2–10	Buff stratified medium to fine sand.
10–36	Grey pebbly sandy silt till.
36–77	Stratified grey, buff, and orange fine sand and silt with peaty layers. Faulted and contorted.
77–87	Dark-grey faulted clayey silt.
87–106	Slump to river.

F137

FOOTAGE	
0–4	Weathered sandy till.
4–7	Buff gravelly sand.
7–9	Boulder gravel.
9–11	Substratified buff sandy till.
11–17	Coarse sand and fine gravel.
17–20	Buff sandy till.
20–36	Grey silty sand till.
36–40	Buff fine sand.
40–57	Dark-grey micaceous silt till with few pebbles.
57–82	Slump to River.

F251 — Little Rouge Creek west of Kingston Road

FOOTAGE	
0–26	Buff slightly-sandy silt till. Boulder layer at 20 feet.
26–28	Brown stratified medium sand with minor peat.
28–31	Dark-grey peaty silt.
31–32	Buff medium sand with peat and clay balls.
32–38	Stony silt till; rich in shale pebbles.
38–	Shale at river level.

F169

FOOTAGE	
0–20	Buff sandy till. Lower 6 feet interbedded with sand.
20–27	Stratified coarse-to-medium buff sand and fine gravel.
27–28	Grey-buff silty sand till.
28–35	Contorted buff fine silty sand.
35–60	Slump. Seems to be stratified sand and gravel.
60–65	Shaly silt till. Sedimentary dike 2 inches thick filled with coarse sand strikes at 110°. Till mass looks like a slump block. River level.

LITTLE ROUGE CREEK

H2

FOOTAGE	
0–15	Buff sandy till.
15–27	Grey sandy till. Oxidized along vertical joints.
27–36	Slump to creek.

H3

FOOTAGE	
0–18	Buff sandy till.
18–35	Hard grey sandy till. Creek level.

H4

FOOTAGE	
0–13	Buff sandy till.
13–18	Grey sandy till.
18–35	Slump.
35–41	Grey sandy till. Creek level.

H12

FOOTAGE	
0–8	Buff sandy till.
8–17	Poorly-sorted subangular kamy sand and gravel.
17–22	Buff sandy till.
22–24	Grey sandy till.
24–39	Slump to creek.

H11

FOOTAGE	
0–5	Stratified rounded medium-to-coarse sandy gravel.
5–12	Brown laminated clay. Varved (¼-inch thick) in lower part.
12–26	Sandy till with sand lenses. Creek level.

H13

FOOTAGE	
0–3	Buff stratified clay. Thickness varies.
3–23	Buff sandy till. Water-bearing gravel lens at 20 feet.
23–41	Grey sandy till.
41–72	Slump to creek. Elsewhere up to 6 feet of silt till with few pebbles.

H144

FOOTAGE	
0–5	Buff sandy till.
5–18	Grey sand till.
18–37	Grey silt till; fewer stones than till above.
37–39	Clayey silt till; stonefree.
39–55	Dark-grey silt till, with few pebbles. Creek level.

H143

FOOTAGE	
0–5	Alluvial boulder gravel.
5–20	Dark-grey clayey silt till with very few stones. Remanent stratification. Creek level.

H142

FOOTAGE	
0–2	Alluvial gravel.
2–15	Dark-grey silt till with few pebbles.
15–32	Slump to creek. At creek bed, same till.

H141

FOOTAGE	
0–2	Sandy soil and boulders.
2–21	Grey hard silty sand till.
21–22	Coarse sand and fine gravel.
22–85	Grey silty sand till.
85–100	Buff-to-grey fine sand and silty sand.
100–108	Dark-grey silt till with few pebbles. Contorted remanent stratification. Creek level.

H140

FOOTAGE	
0–11	Grey sandy stony till.
11–15	Contorted stratified brown sand.
15–23	Grey sandy till.
23–25	Stratified grey medium to silty sand.
25–31	Grey sandy till.
31–33	Dark-grey silty clay (till?).
33–37	Stratified grey-buff contorted silt. Creek level.

H139

FOOTAGE	
0–10	Stratified buff-to-grey fine sand. One foot of sandy till at 7 feet.
10–16	Buff sandy till with 6-inch sand layers.
16–35	Grey hard silty sand-till.
35–46	Slump. Transferred section 100 feet downstream.
46–55	Stratified pink-buff silty sand.
55–59	Grey clayey silt with silty sand partings.
59–83	Slump to creek.

H249

FOOTAGE	
0–4	Buff silty sand.
4–12	Grey-buff very-dense silty sand with pebbles.
12–31	Grey silty sand till.
31–79	Slump to creek. Bedrock at creek level; grey to black shale.

H250 — Composite section in road cut and river bank

FOOTAGE	
0–2	Brown sandy soil.
2–5	Stratified buff fine gravelly sand.
5–11	Buff sandy till.
11–18	Grey silty sand till.
18–23	Massive sand (till?).
23–25	Grey silty sand till.
25–35	Slump to road.
35–92	Covers interval to river bank.
92–105	Stratified sand and silt with peat.
105–114	Black shale bedrock to river level.

H252

FOOTAGE	
0–18	Stratified silt, clayier downward.
18–24	Slump.
24–36	Shale bedrock.

WEST DUFFIN CREEK

J54

FOOTAGE	
0–4	Fine-to-medium sandy gravel. Thickens to 8 feet to south.
4–8	Grey-buff sandy till; pebbles small.
8–28	Sandy stony till; grades southward into kame gravel.
28–35	Grey sandy till.
35–47	Slump. Transferred section across river.
47–53	Grey silt till with few pebbles. Many silt balls. Creek level.

J101

FOOTAGE	
0–2	Sandy soil.
2–4	Sandy stony buff till.
4–17	Sandy buff till.
17–20	Buff fine sand; till inclusion.
20–26	Buff sandy stony till with sand lenses.
26–29	Buff silty sand.
29–34	Buff sandy till.
34–36	Rounded gravel and sand.
36–51	Slump.
51–58	Clayey silt till with few pebbles. Creek level.

J100

FOOTAGE	
0–2	Alluvial sandy gravel:
2–4	Buff sandy till.
4–29	Stratified buff silty sand. Clay layer at 10 feet.
29–32	Stratified clay and sand.

J48

FOOTAGE
0–47 Sandy buff till. One foot of sand at 25 feet. Till mostly stony below sand layer.
47–106 Stratified grey fine sand, grading downward into silt.
106–112 Stratified grey silt and clay. Some graded bedding. Creek level.

J95

FOOTAGE
0–16 Buff sandy till; fairly stony. Sand layer at 5 feet.
16–71 Stratified buff fine sand and grey silt.
71–77 Slump.
77–83 Grey, laminated to varved, clay.
83–87 Slump to creek.

J47

FOOTAGE
0–4 Coarse gravel; alluvial.
4–40 Stratified fine sand. Siltier to base. Contortions near base.
40–60 Stratified silt and clay. Lenses of till, granules, silt balls, cobbles, and boulders in lower 3 feet; this part disturbed by faulting. Creek level.

J94

FOOTAGE
0–4 Interbedded fine sand and pebbly silty sand (till?).
4–10 Buff silty sand till.
10–52 Buff fine stratified sand and silty sand.
52–78 Grey stratified silt and clay.
78–82 Grey slightly-sandy silt till; substratified. Creek level.

J96,-99

FOOTAGE
0–53 Buff sandy till. Layer of fine sand at 45 feet.
53–99 Slump.
99–119 Grey stratified-to-varved clay.
119–128 Grey clayey silt till with few pebbles. Occasional thin clay layers (varves) contorted in till. Creek level.

J98

FOOTAGE
0–17 Buff sandy till.
17–19 Buff fine sand.
19–20 Buff sandy till. Creek level.
20–34 Buff stratified silty sand. Till lenses near top. Contortions and whorls in the sand.
34–71 Slump.
71–76 Grey clayey silt till. Upper foot substratified. Creek level.

J49

Footage	
0–15	Stratified yellow medium-to-fine sand.
15–30	Grey sandy till.
30–35	Sand and gravel.
35–57	Grey sandy till.
57–81	Buff-to-grey stratified fine dense sand.
81–103	Grey stratified silt and clay.
103–118	Slump to creek.

J51

Footage	
0–9	Stratified fine silty sand. Contorted.
9–58	Grey sandy till.
58–60	Buff stratified silty sand.
60–120	Slump.
120–125	Thin layers of till interbedded with clay bands. Creek level.

J97

Footage	
0–28	Buff sandy till.
28–54	Grey sandy till; stony.
54–60	Buff sandy till with few pebbles.
60–85	Stratified buff dense silty sand. Some clay layers showing symmetrical ripple marks.
85–91	Grey stratified silt and sand.
91–115	Mostly slump. Intermittent exposures of stratified clay.
115–120	Stratified grey clay. Creek level.

J50

Footage	
0–11	Buff and grey sandy till.
11–60	Stratified-to-varved sand and silt. Contorted at top. Creek level.

J52

Footage	
0–16	Buff sandy till, grey below 11 feet.
16–30	Dense buff-and-grey stratified silty sand.
30–45	Slump.
45–50	Grey stratified silty clay. Creek level.

J53

Footage	
0–2	Sandy soil and lenses of sand and gravel.
2–13	Grey-buff sandy till.
13–34	Grey sandy till.
34–86	Slump to creek.

APPENDIX B

Pollen Analyses

(Results of Studies by J. Terasmae and R. J. Mott, Geological Survey of Canada)

(a) SAMPLES FROM SCARBOROUGH FORMATION

F251 — Left Bank of Little Rouge Creek north of Kingston Road. Samples from between tills similar to York Till (below) and Sunnybrook Till (above).

Pollen Type	Number of Grains Counted			
	Sample No. 1 (bottom)	*Sample No. 2*	*Sample No. 4*	*Sample No. 5*
Black spruce	14	9	4	9
White spruce	34	22	17	13
White pine	8	4	2	3
Jack pine	72	80	59	78
Balsam fir	3	1	1	—
Hemlock	1	—	—	—
Tamarack	2	1	—	1
Birch	1	2	9	12
Alder	4	—	7	1
Oak	3	—	2	5
Beech	1	—	—	—
Elm	—	—	—	1
Basswood	—	—	—	1
Hickory	—	—	—	1
Willow	—	1	1	—

Sphagnum spores are fairly abundant in all samples. Nontree pollens in general are few in numbers and composed of grass, sedge, *Artemisia,* Chenopodiaceae, Compositae, and Ericaceae. Some fern spores and *Lycopodium* are present together with moss spores.

These pollen assemblages indicate that the sediments belong to the lower member of the Scarborough beds. Boreal to subarctic climate is indicated. Some redeposition of pollen may have taken place.

(b) SAMPLES FROM THE THORNCLIFFE FORMATION, OVERLYING SUNNYBROOK TILL

F120 — Right bank of Rouge River south of Finch Avenue

Pollen Type	Number of Grains Counted		
	Sample No. 1	*Sample No. 1A*	*Sample No. 2*
Black spruce	2	3	—
White spruce	6	9	3
Jack pine	21	19	8
Balsam fir	—	2	1
Birch	3	—	—
Oak	—	5	1
Basswood	—	2	1
Artemisia	—	—	1
Polypodiacea	2	2	—
Sphagnum	1	1	—
Moss and fungus	present	present	present
Lycopodium	1	—	—

The above assemblages are similar to those obtained from the upper member of the Scarborough beds at the type locality and indicate cold climatic conditions for the area. The possibility that some of the pollen may be redeposited from some earlier and also contemporaneous beds cannot be eliminated. This, however, does not contort the general aspect of the pollen assemblages; only the detail.

A1013 — Scarborough Bluffs, east of Meadowcliffe Drive

Pollen type	Percentage of total tree pollen	Pollen type	Percentage of total tree pollen	Pollen type	Percentage of total tree pollen
Black spruce	11.7	Hickory	2.0	*Comptonia*	2.0
White spruce	8.7	Basswood	1.0	Rosaceae	1.0
Jack pine	59.2	*Artemisia*	1.0	Ranunculaceae	1.0
Balsam fir	1.0	*Ambrosia*	2.0	Unknown	3.8
Birch	8.7	Compositae	1.0	*Sphagnum*	11.7
Alder	1.0	Chenopodiaceae	2.0	Fern spores	1.0
Willow	2.9	Caryophyllaceae	1.0	*Osmunda*	1.0
Oak	2.9	Ericaceae	1.0	Fungus and moss	present
Elm	2.9	Gramineae	2.0		

The assemblage shown above is the same as that found in sample M1017a from Scarborough Bluffs.

A1017 — Scarborough Bluffs, near Sylvan Avenue

Pollen type	Percentage of total tree pollen	Pollen type	Percentage of total tree pollen	Pollen type	Percentage of total tree pollen
Black spruce	9	Oak	7	*Ambrosia*	1
White spruce	9	Elm	3	Graminae	1
White pine	2	Ash	2	Polypodiaceae	2
Jack pine	58	Hickory	3	*Sphagnum*	5
Balsam fir	1	Basswood	1	Pre-Pleistocene spores	
Birch	4	Hazel	1	Moss and	
Alder	1	*Artemisia*[1]	15	fungus spores	present

[1]14 of the 16 grains counted were found in one clump.

The assemblage found in this sample is much like the assemblage found in the Scarborough beds and indicates a similar boreal climate. This sample, however, overlies the Sunnybrook Till; the latter, in turn, overlies the Scarborough beds. The samples from the Rouge River section studied at an earlier date are also similar in general but differ slightly in detail.

More work is required on the sediments above the Sunnybrook Till before it can be determined how much of the pollen is from reworked Scarborough beds and how much is indicative of the vegetation growing during the time of the Sunnybrook Till.

The small clump of *Artemisia* pollen found in this sample indicates that this plant grew on the site and was not redeposited from older material.

(c) SAMPLES OF TILLS

A — Sunnybrook Till, A1009 Seminary section.
B — Sunnybrook Till, A1017.
C — Seminary Till, A1009, Seminary section.
D — Meadowcliffe Till, A1009, Seminary section.

Pollen Type	Number of Grains Counted			
	Sample No. A	*Sample No. B*	*Sample No. C*	*Sample No. D*
Black spruce	6	9	4	3
White spruce	7	4	4	4
Jack pine	42	40	22	16
Balsam fir	—	—	—	1
Birch	1	1	1	present
Alder	1	present	present	present
Oak	—	—	present	present
Elm	—	present	—	—
Artemisia	present	1	1	1
Ambrosia	—	present	—	—
Compositae	—	1	—	—
Ericaceae	—	—	present	—
Caryophyllaceae	—	—	present	—
Chenopodiaceae	—	present	—	—
Nemopanthus	—	present	—	—
Unknowns	2	—	2	—
Sphagnum	—	1	2	present
Polypodiaceae	1	1	present	1
Lycopodium	1	present	1	—

The pollen and spore assemblages present in the four till samples are very similar to each other and also to other assemblages obtained previously from intertill sands. These assemblages are also somewhat similar to those of the Scarborough beds; but the Scarborough beds contain many more pollen grains of hardwood species.

The Sunnybrook Till probably contains material redeposited both from the Scarborough beds and from whatever deposits (if any) were present above the Scarborough beds and were subsequently eroded. Tills No. 2 [Seminary Till] and No. 3 [Meadowcliffe Till] may also contain some redeposited Scarborough beds but more likely the material is from sediments laid down since the deposition of the Sunnybrook Till.

It seems probable, therefore, that the intertill sediments represent deposition during an interstadial interval (or intervals) when the ice margin fluctuated in the Toronto region.

(d) POSTGLACIAL SAMPLES

F9 — North of Steele's Avenue, west of Rouge River. Marl at edge of river terrace

	Number of Grains Counted	
Pollen Type	*Sample No. TB60-59*	*Sample No. TB60-62 (bottom)*
Black spruce	13	—
White spruce	4	1
White pine	38	5
Jack pine	131	31
Balsam fir	6	5
Tamarack	—	1
Birch	6	1
Oak	3	—
Elm	1	—

Nontree pollens are rare. Fungus and moss remains are present.

These assemblages are indicative of boreal conditions and a tentative correlation with known pollen diagrams of postglacial sediments suggest an age of 7,000–8,000 years for the base of this organic deposit. Such pollen assemblages are characteristic of pollen-zone IV in Terasmae's system.

APPENDIX C

Localities where samples were obtained

H2–Little Rouge Creek. (See Figure 12)
F7–Rouge River. (See Figure 10)
10–¼ mile southwest of Browns Corners; lot 19, con.III, Scarborough twp.
H12–Little Rouge Creek. (See Figure 12)
F16, F20–Rouge River. (See Figure 10)
27–Lawrence Ave. East and Highland Creek; lot 27, con.D, Scarborough twp.
D44–East Highland Creek. (See Figure 8)
J47, J49, J54–West Duffin Creek. (See Figure 13)
F58–Rouge River. (See Figure 10)
J94, *J97–West Duffin Creek. (See Figure 13)
F115–Rouge River. (See Figure 10)
118–Petticoat Creek. Range L, lot 32, Pickering twp.
F119, F120, F121, F122–Rouge River. (See Figure 10)
125–West tributary to Rouge River, ½ mile north of Sheppard Ave. and ½ mile east of Morningside Ave.; lot 8, con.III, Scarborough twp.
G128–West tributary to Rouge River. (See Figure 11)
F135, F138–Rouge River. (See Figure 10)
H139–Little Rouge Creek. (See Figure 12)
D146–East Highland Creek. (See Figure 8)
C158, C162, C165–West Highland Creek. (See Figure 7)
F169–Rouge River. (See Figure 10)
D170–East Highland Creek. (See Figure 8)
173–Giordano gravel pit, Whitevale; lot 31, con.V, Pickering twp.
176–Sabiston sand pit, 2 miles east of Thornhill; lot 3, con.II, Pickering twp.
177–Markham Sand and Gravel pit, 5 miles southwest of Markham; lot 6, con.IV, Markham twp.
184–Gulley west of Ridgemoor Ave. and south of Kingston Rd.
185–Gulley west of Chine Dr. near Undercliff Dr.
190–Heathfield Dr. and Hill Cres., top of Iroquois Bluff.
195–Little Rouge Creek, ½ mile north of Twyn Rivers Dr., lot 2, con.III, Scarborough twp.
196–Little Rouge Creek, ¾ mile north of Twyn Rivers Dr., lot 3, con.III, Scarborough twp.
D203–East Highland Creek. (See Figure 8)
207–Little Rouge Creek, Kirkhams Rd. and Passmore Ave., lot 5, con.V, Scarborough twp.
215–Phyllis Ave., west of McCowan Rd., sewer excavation.
216–Colonial Ave., east of McCowan Rd., sewer excavation.
D224–East Highland Creek. (See Figure 8)
C225–West Highland Creek. (See Figure 7)
230–Creek west of Orton Park Ave. and ⅓ mile north of Lawrence Ave. E., lot 15, con.I, Scarborough twp.
231–Creek west of Orton Park Ave. and south of Lawrence Ave. E., lot 15, con.D, Scarborough twp.
E245–Lower Highland Creek. (See Figure 9)
F246, F251–Rouge River. (See Figure 10)
B261, B262, B265, B266–Massey Creek. (See Figure 6)
285–Petticoat Creek; lot 32, con.I, Pickering twp.
*293–House excavation, north of Rouge River, south of Highway 7, Markham; lot 10, con.VIII, Markham twp.
510–Leslie Ave. and Steele's Ave.; lot 1, con.II, Markham twp.
511–Leslie Ave. and Steele's Ave.; lot 1, con.III, Markham twp.
917–Lawrence Ave. E., west of Orton Park Rd.; lot 15, con.I, Scarborough twp.
A1000, A1001, A1004, A1005, A1006, A1009, A1010, A1011, A1012, A1013, A1017, A1018, A1019, A1020, A1021, A1022, A1024, A1027, A1028–Scarborough Bluff. (See Figure 5)
*1034–Lake Ontario shore, 1 mile northeast of Port Union; lot 32, range II, Pickering twp.
*1035–Lake Ontario shore, ½ mile southwest of Fairport Beach, lot 30, range II, Pickering twp.
*Whitby West–Lake Ontario shore, west of Whitby Harbour.
*Leaside–C.P.R. cut at Leacrest Rd., Leaside.
*Don Brick–Toronto Brick Co., Don Valley Works, ½ mile north of Prince Edward viaduct, Danforth Ave.

*Samples from outside the map-area.

APPENDIX D

Table I. Analyses of till samples

Notes
1. Mechanical-analyses size limits: sand >0.062 mm.; silt 0.062-0.004 mm.; clay <0.004 mm.
2. Pebble counts made on pebbles 1–2 in. in diameter.
3. Carbonate analyses on till matrix <0.074 mm. in diameter according to method of Dreimanis (1962).
4. Till No.: 4B — Upper Leaside Till; 4A — Lower Leaside Till; 3 — Meadowcliffe Till; 2 — Seminary Till; 1 — Sunnybrook Till; Ill. — York Till.

Sample No.	Till No.	Mechanical Analysis				Pebble Counts					Carbonate Analysis			
		Clay	Silt	Sand	Median Diameter	Limestone	Dolomite	Shale	Sandstone	Precambrian	Calcite	Dolomite	Total Carbonate	Ratio of Calcite to Dolomite
H2	4	22	29	49	0.058	74	—	10	—	13	36	4	40	9.0
F7	4	16	31	53	0.075	—	—	—	—	—	—	—	—	—
10	4	26	50	24	0.12	77	—	5	—	17	—	—	—	—
H12A	4B?	14	32	54	0.078	—	—	—	—	—	—	—	—	—
H12B	4A?	20	24	56	0.100	—	—	—	—	—	—	—	—	—
H12D	4A	23	30	47	0.043	—	—	—	—	—	—	—	—	—
16	1	44	37	19	0.0057	—	—	—	—	—	—	—	—	—
16	4A	9	38	53	0.072	84	—	5	—	10	—	—	—	—
16	4B	—	—	—	—	71	—	18	1	10	—	—	—	—
20	4	11	33	56	0.085	—	—	—	—	—	34	2	36	17.0
27	4	28	31	41	0.030	62	—	21	1	14	27	7	34	3.9
44	3?	44	34	22	0.0057	—	—	—	—	—	20	9	29	2.2
47	1?	38	30	32	0.009	—	—	—	—	—	—	—	—	—
49	4A?	21	37	42	0.041	—	—	—	—	—	—	—	—	—
54	1?	31	34	35	0.022	—	—	—	—	—	24	8	32	3.0
58	4?	20	43	37	0.033	—	—	—	—	—	—	—	—	—
J94A	1?	50	26	24	0.004	—	—	—	—	—	28	7	35	4.0
J94B	4	17	29	54	0.075	—	—	—	—	—	—	—	—	—
F115A	4?	32	28	40	0.019	—	—	—	—	—	—	—	—	—
F115B	1	44	29	27	0.0055	—	—	—	—	—	—	—	—	—
118	4	17	32	51	0.065	—	—	—	—	—	31	6	37	5.2
119	1	48	35	17	0.0045	—	—	—	—	—	7	9	16	0.8
F120A	1	53	44	3	0.0035	—	—	—	—	—	—	—	—	—
F121A	4?	35	27	38	0.017	—	—	—	—	—	—	—	—	—
F122A	4?A?	23	34	43	0.038	—	—	—	—	—	—	—	—	—
F122B	1?	21	53	26	0.022	—	—	—	—	—	—	—	—	—
125	4?	15	31	54	0.077	—	—	—	—	—	—	—	—	—
128	1?	31	41	28	0.014	—	—	—	—	—	—	—	—	—
135	4?	20	35	45	0.044	—	—	—	—	—	—	—	—	—
138	4?	29	31	40	0.028	—	—	—	—	—	—	—	—	—
139	4?	23	29	48	0.052	—	—	—	—	—	—	—	—	—
146	3?	27	66	7	0.015	—	—	—	—	—	22	9	31	2.4

APPENDIX D

Table II. Analyses of till samples by R. C. Ostry

Sample No.	Till No.	Mechanical Analysis				Pebble Counts					Carbonate Analysis			
		Clay	Silt	Sand	Median Diameter	Limestone	Dolomite	Shale	Sandstone	Precambrian	Calcite	Dolomite	Total Carbonate	Ratio of Calcite to Dolomite
16	1	55	29	16	0.0025	84	6	1	1	5	16	11	27	1.5
16	4A	20	35	45	0.043	84	0	5	0	10	24	10	34	2.4
16	4B	15	31	54	0.075	71	0	18	0	10	34	4	38	8.5
97	1?	64	31	5	0.002	82	6	4	2	6	32	7	39	4.6
97	4B	27	26	47	0.05	81	1	1	0	17	21	3	24	7.0
120	1	55	29	16	0.003	72	12	0	10	6	9	11	20	0.8
120	4A	21	34	45	0.048	78	4	0	0	18	27	10	37	2.7
120	4B	28	27	45	0.043	72	1	3	0	24	19	3	22	6.3
121	1	70	20	10	0.001	58	18	0	8	16	3	5	8	0.6
121	4A	13	17	70	0.130	83	6	1	0	10	22	8	30	2.8
121	4B	21	37	52	0.065	77	3	0	0	20	20	3	23	6.7
176	4A	15	48	37	0.035	84	1	4	0	11	27	6	33	4.5
177	1	55	36	9	0.003	51	8	25	0	16	11	14	25	0.8
177	4A	15	36	49	0.060	—	—	—	—	—	29	9	38	3.2
177	4B	10	26	64	0.120	—	—	—	—	—	26	3	29	8.7
230	1	30	42	28	0.023	—	—	—	—	—	13	8	21	1.6
230	4B	23	36	41	0.037	—	—	—	—	—	20	6	26	3.3
231	1	62	31	7	0.0025	50	20	1	14	18	11	6	17	1.8
251	III.	18	23	59	0.170	22	0	75	0	3	23	6	29	3.8
251	1	30	33	37	0.024	64	7	6	2	21	20	6	26	3.3
262	4A	18½	41	41	0.040	73	3	15	0	9	29	8	37	3.6
262	4B	25	42	43	0.035	60	0	31	0	9	24	5	29	4.8
266	1	59	26	15	0.002	59	15	0	13	14	4	5	9	0.8
917	4B	15	30	55	0.07	—	—	—	—	—	23	5	28	4.6
1009	2	26	18	56	0.084	53	5	31	0	11	19	7	26	2.7
1009	3	48	35	17	0.0045	44	3	30	0	23	26	6	32	4.3
1022	1	38	39	23	0.009	55	7	35	2	3	16	6	22	2.7
Don Brick	III.	26	24	50	0.06	30	0	68	0	2	9	4	13	2.3
Don Brick	1	31	39	30	0.02	—	—	—	—	—	12	5	17	2.4
Don Brick	1?	50	30	20	0.004	—	—	—	—	—	19	5	24	3.8
Leaside	4B	24	30	46	0.04	—	—	—	—	—	16	3	19	5.3

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Maps

Ontario Dept. Mines

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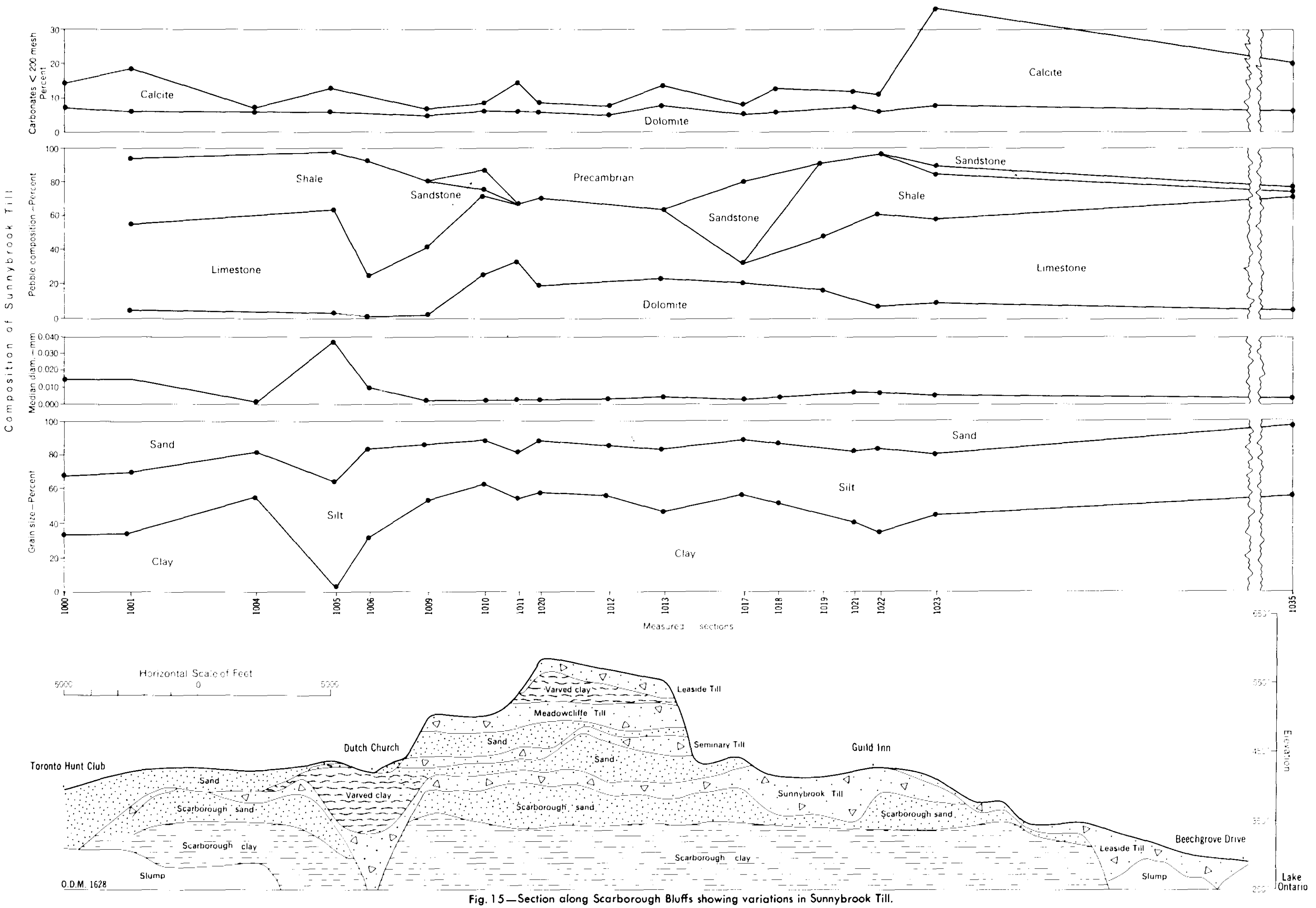

Fig. 15—Section along Scarborough Bluffs showing variations in Sunnybrook Till.

INDEX

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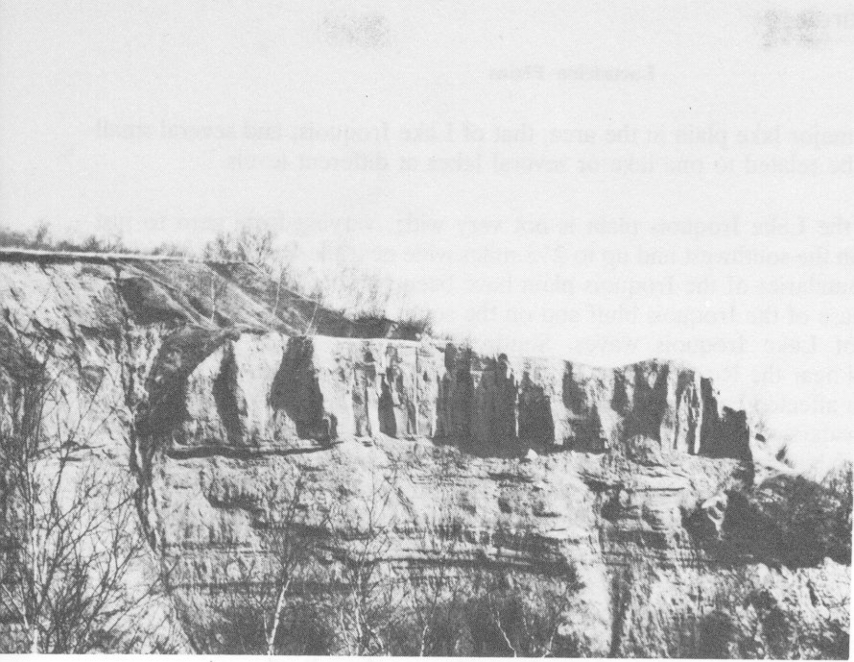
1/4
1/2
3/4
1
SCALE IN MILES



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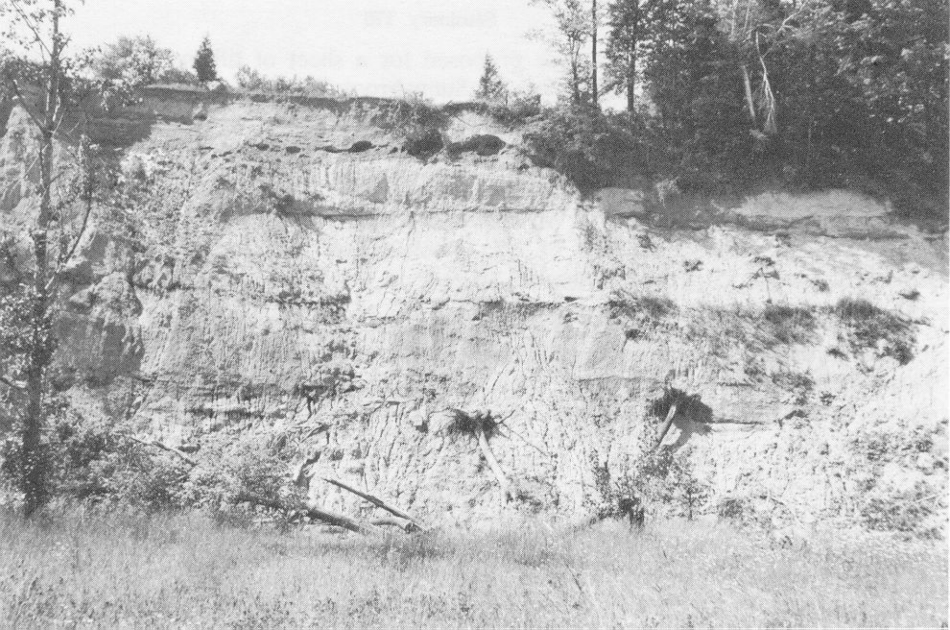
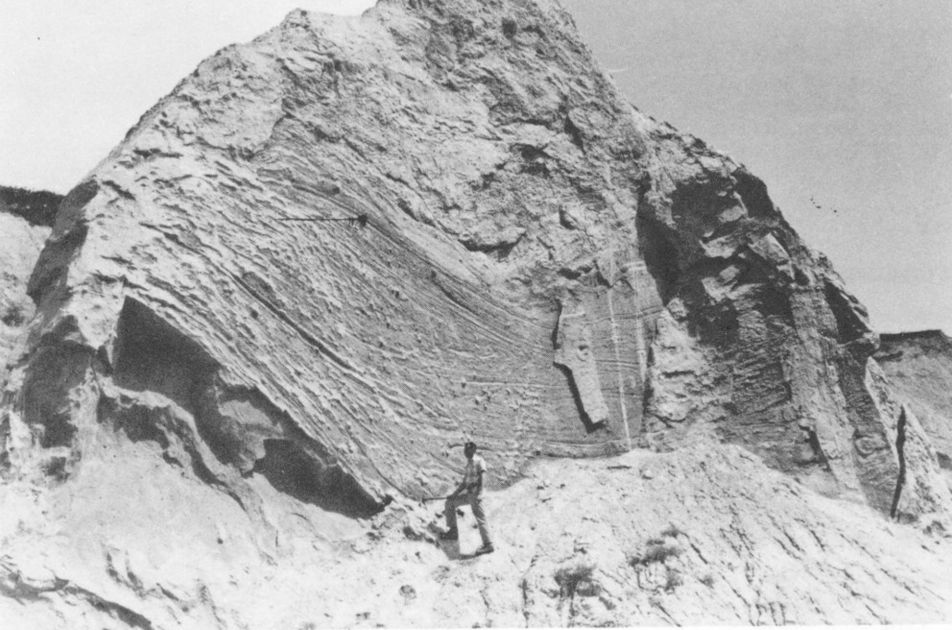




Scarborough Area Report
Chart A
Location of Pleistocene Sections

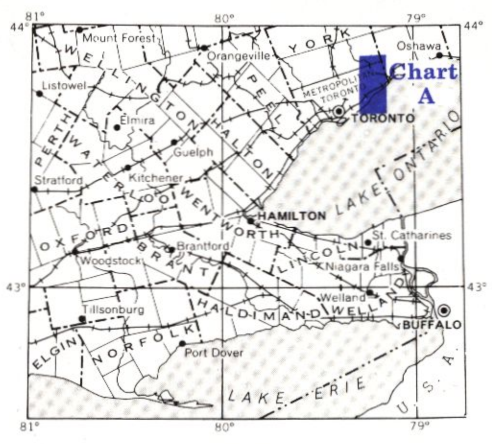


Chart A

LOCATION OF PLEISTOCENE SECTIONS

Accompanying Maps 2076, 2077 and Chart B

Scale 1 Inch to ½ Mile

Published 1965

SYMBOLS

Topographic contours.

C153 Location of measured section with number.

All sections are measured from a base at the nearby stream or lake level.

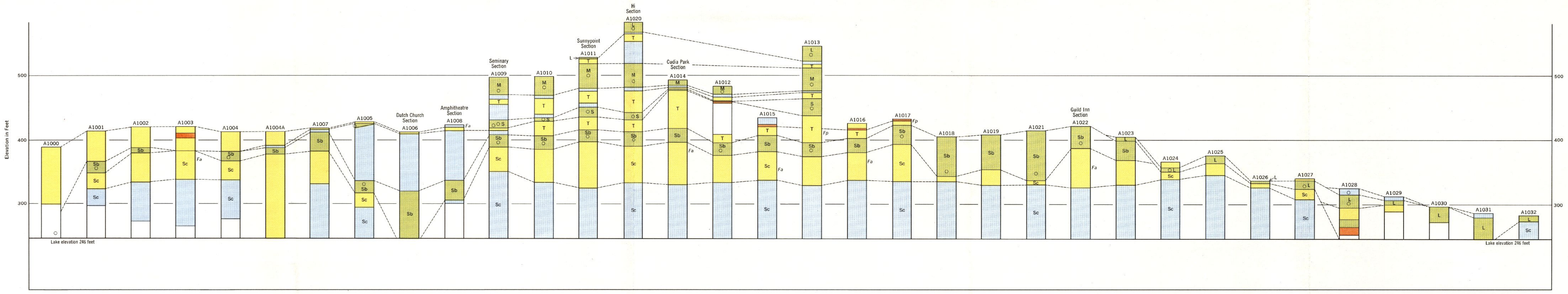


Figure 5 – Measured sections along Lake Ontario shore at Scarborough Bluffs.

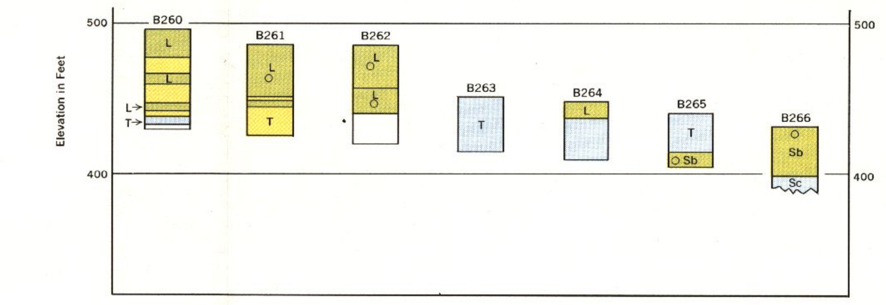


Figure 6 – Measured sections along Massey Creek.

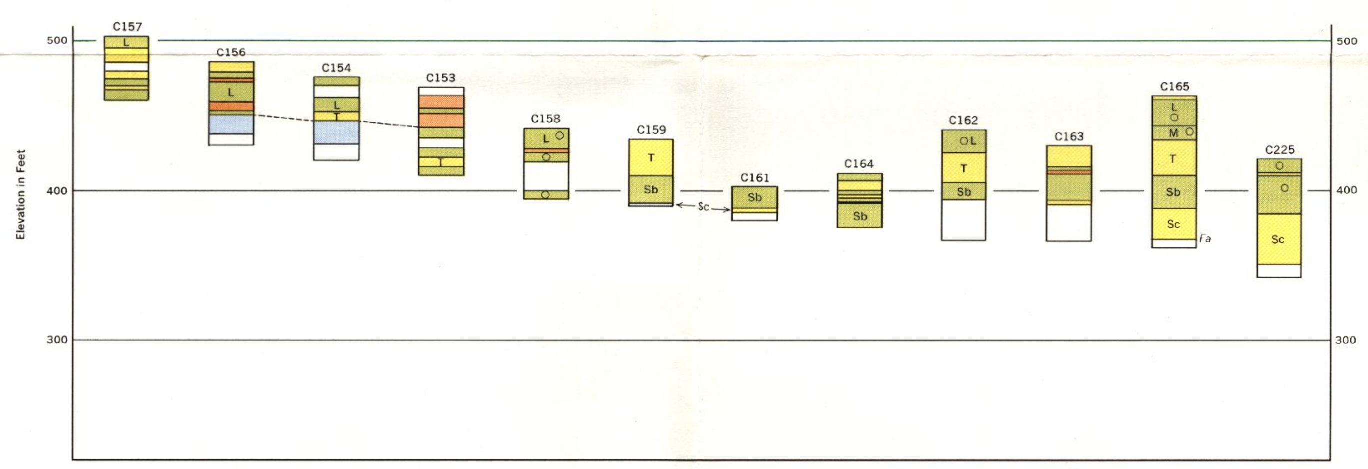


Figure 7 – Measured sections along west tributary of Highland Creek.

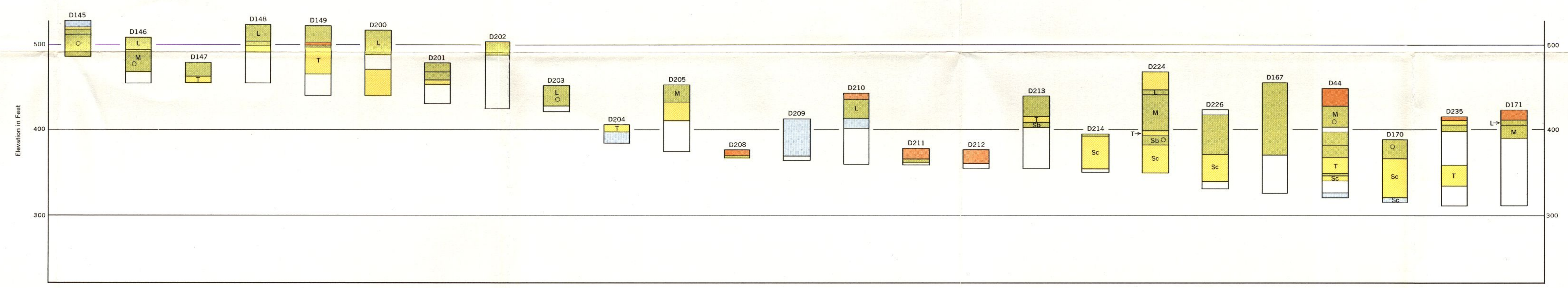


Figure 8 – Measured sections along Highland Creek.

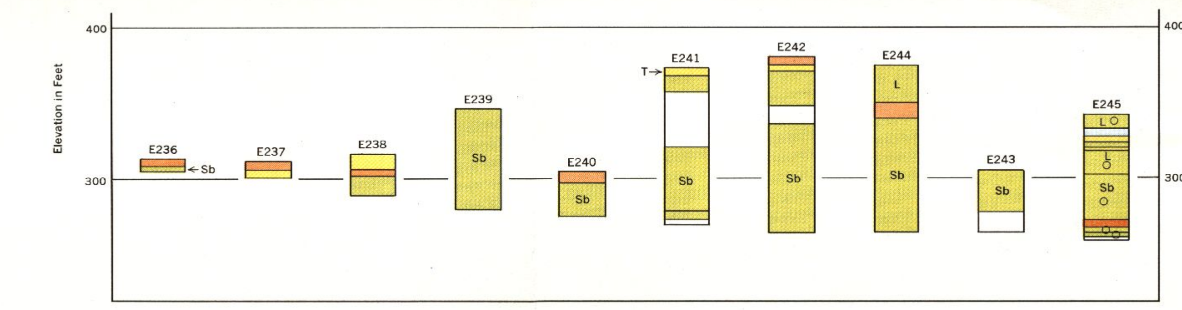


Figure 9 – Measured sections along lower Highland Creek.

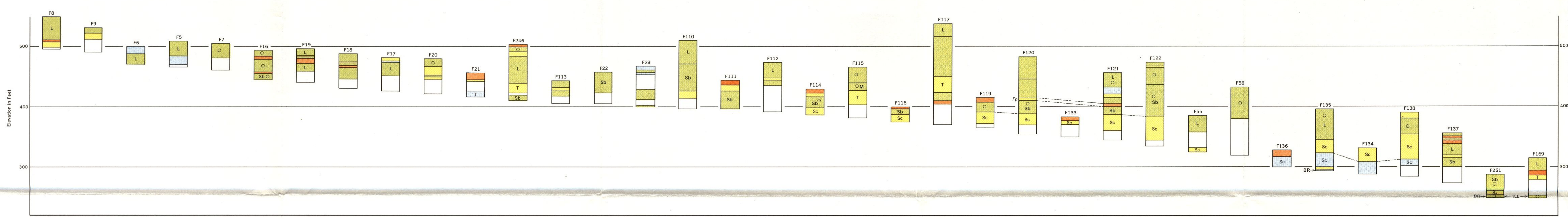


Figure 10 – Measured sections along Rouge River.

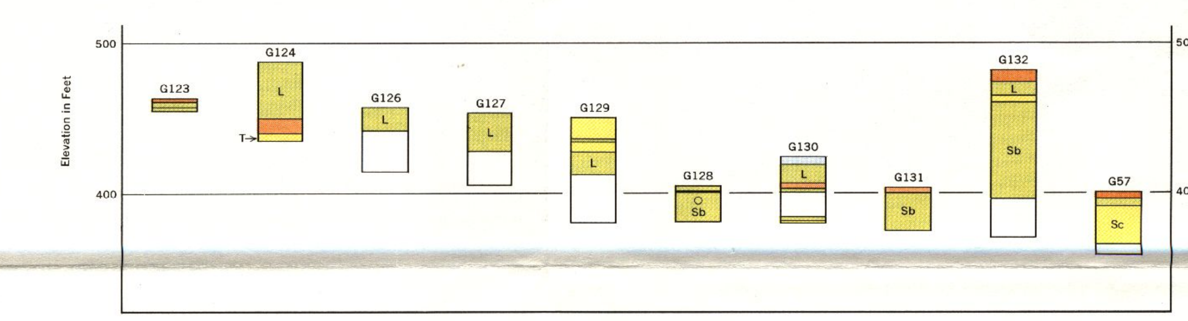


Figure 11 – Measured sections along west tributary of Rouge River.

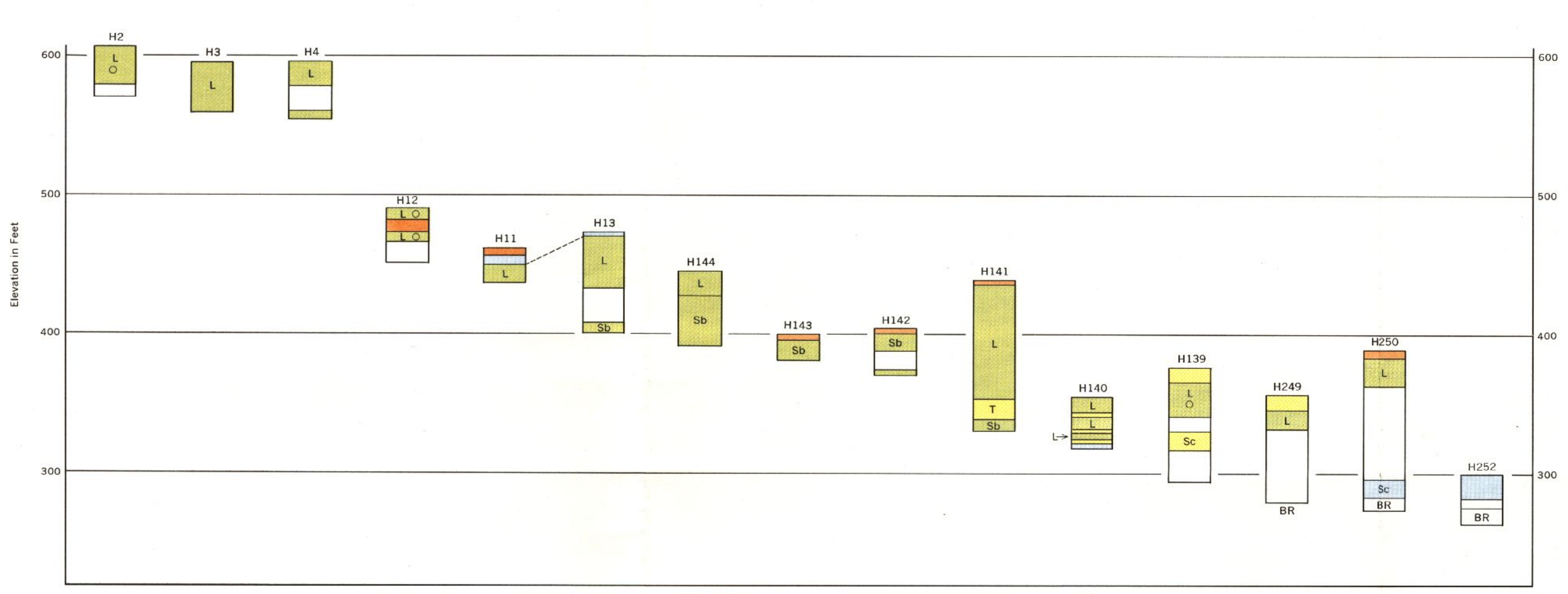


Figure 12 – Measured sections along Little Rouge Creek.

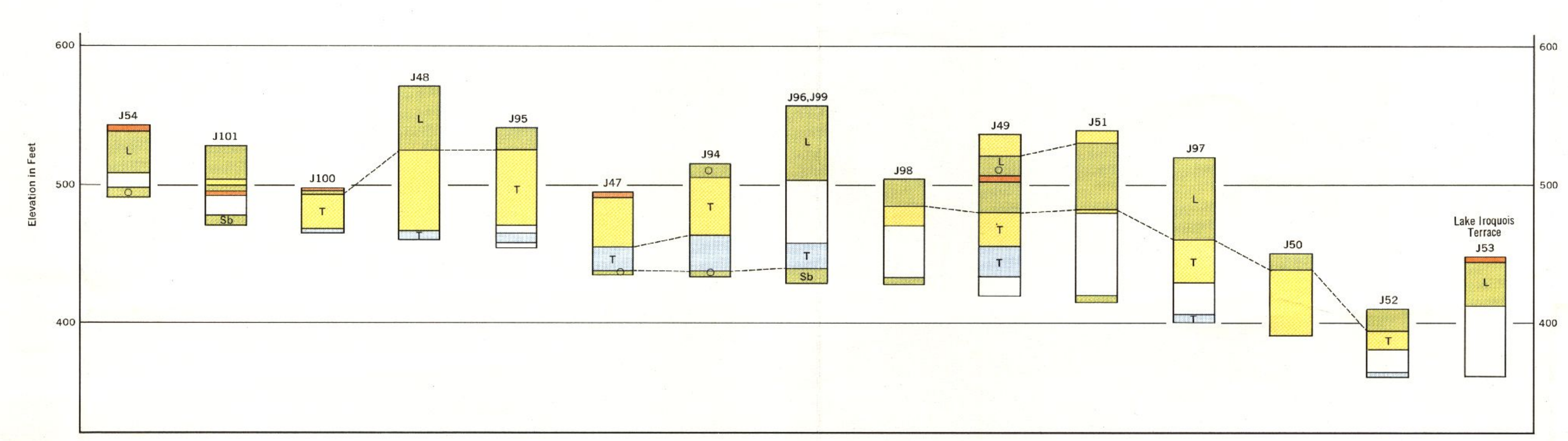


Figure 13 – Measured sections along West Duffin Creek.

LEGEND

(yellow-olive)	*Till.*
(pale blue)	*Clay.*
(yellow)	*Sand.*
(orange)	*Gravel.*
O	*Sample site.*
Fa	*Fossil locality, animal remains.*
Fp	*Fossil locality, plant remains.*
L	*Leaside Till.*
M	*Meadowcliffe Till.*
S	*Seminary Till.*
Sb	*Sunnybrook Till.*
T	*Thorncliffe Formation.*
Sc	*Scarborough Formation.*
ILL	*Illinoian.*
BR	*Bedrock.*

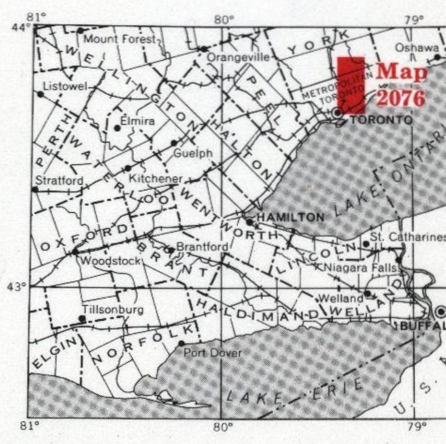
Vertical Scale 1 Inch to 100 Feet

For map locations of these sections, see Chart A.

O.D.M. 1618

Published 1965

Map 2076
Scarborough Area, West Sheet
Pleistocene Geology


Scale 1 inch to 50 miles

ONTARIO
DEPARTMENT OF MINES

HON. G. C. WARDROPE, *Minister of Mines*
D. P. Douglass, *Deputy Minister* M. E. Hurst, *Director, Geological Branch*

Map 2076

Pleistocene Geology of the SCARBOROUGH AREA West Sheet

SOUTHERN ONTARIO

Scale 1:31,680 or 1 Inch to ½ Mile

Chains 80 60 40 20 0 1 2 Miles
Metres 1000 0 1 2 3 Kilometres
Feet 1000 0 5,000 10,000 Feet

Published 1965

LEGEND

CENOZOIC

PLEISTOCENE

RECENT

Alluvium: Gravel, sand, silt, clay, wood.
13a Modern flood plain.
13b Alluvial fans. †

Bog and swamp deposits
12 Muck, peat, marl.

Stream terrace deposits †
11 Gravel and sand.

LATE WISCONSINAN

10 Iroquois beach gravel and sand.

Lacustrine clay
9a Lake Iroquois. †
9b Peripheral lakes.

Sand
8a Lake Iroquois.
8b Peripheral lakes.
8c Outwash. †

LEASIDE TILL
7 Silty sand till.

MEADOWCLIFFE TILL †
6 Silty clay till.

SEMINARY TILL*
5 Sandy clay till.

MIDDLE WISCONSINAN

THORNCLIFFE FORMATION
4a Sand.
4b Clay. †

EARLY WISCONSINAN

SUNNYBROOK TILL
3 Silty clay till.

SCARBOROUGH FORMATION
2 Deltaic sand and clay with peat.

PALEOZOIC

ORDOVICIAN

WHITBY FORMATION †
1 Black shale.

* *The* SEMINARY TILL *appears only in the sections.*

† *These rocks are mapped on the companion sheet.*

SYMBOLS

Township boundary.

Topographic contours.

Geological boundary, approximate.

Sand or gravel pit.

Lake Iroquois shoreline.

For other conventional signs refer to 1:25,000 National Topographic Map Series.

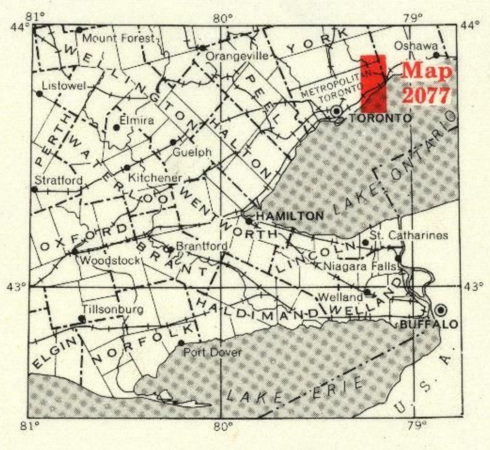
SOURCES OF INFORMATION

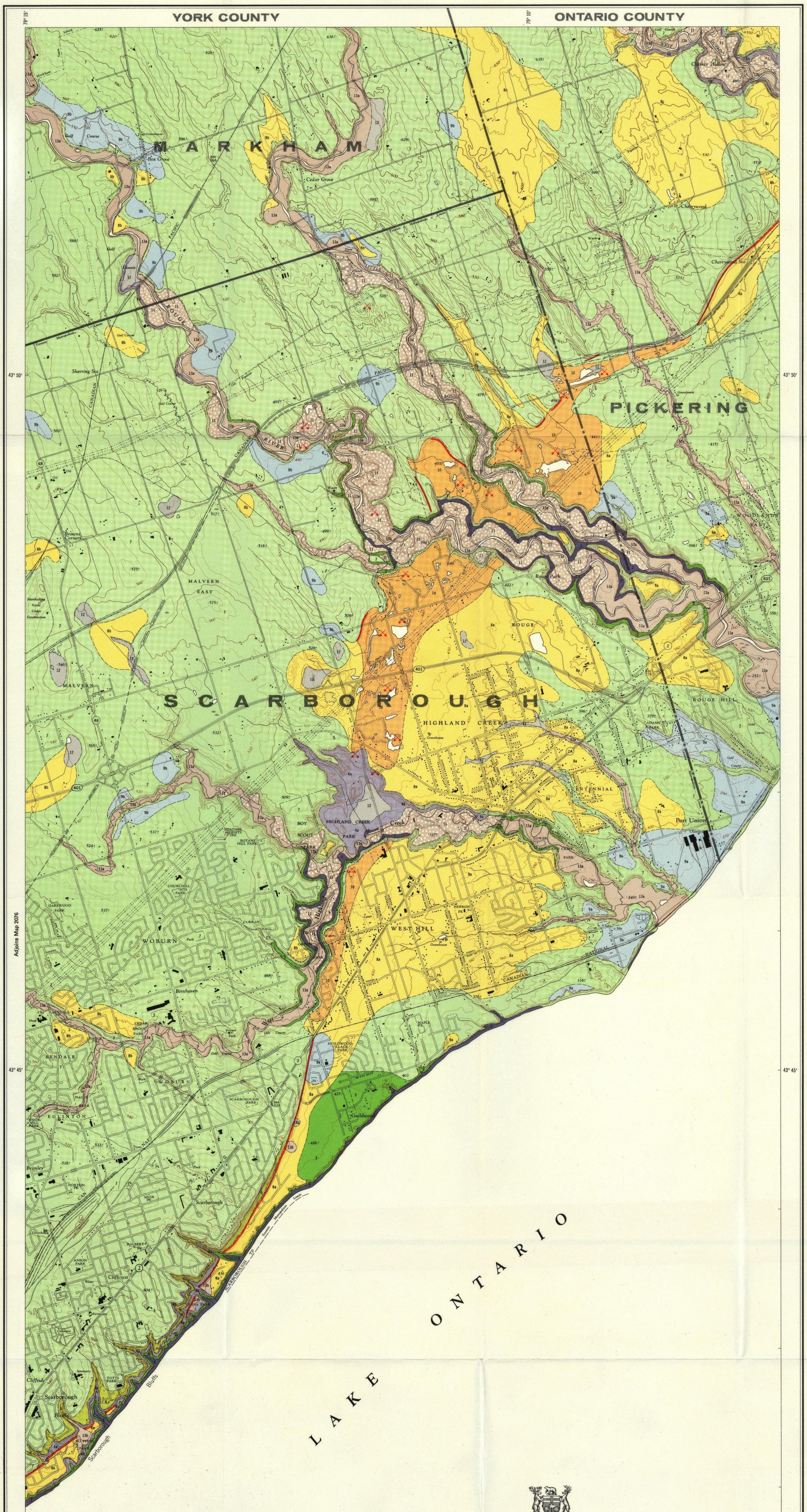
Geology by P. F. Karrow and assistants, 1963.

Cartography by R. G. Curtis and D. V. Impey, Ontario Department of Mines, 1965.

Topography directly from maps 30M/11f, 30M/11g, 30M/14b and 30M/14c of the National Topographic Series.

Magnetic declination approximately 7°W, 1963.





LEGEND

CENOZOIC

PLEISTOCENE

RECENT

Alluvium: Gravel, sand, silt, clay, wood.
13a Modern flood plain.
13b Alluvial fans.

Bog and swamp deposits
12 Muck, peat, marl.

Stream terrace deposits
11 Gravel and sand.

LATE WISCONSINAN

10 Iroquois beach gravel and sand.

Lacustrine clay
9a Lake Iroquois.
9b Peripheral lakes.

Sand
8a Lake Iroquois.
8b Peripheral lakes.
8c Outwash.

LEASIDE TILL
7 Silty sand till.

MEADOWCLIFFE TILL
6 Silty clay till.

SEMINARY TILL*
5 Sandy clay till.

MIDDLE WISCONSINAN

THORNCLIFFE FORMATION
4a Sand.
4b Clay.

EARLY WISCONSINAN

SUNNYBROOK TILL
3 Silty clay till.

SCARBOROUGH FORMATION
2 Deltaic sand and clay with peat.

PALEOZOIC

ORDOVICIAN

WHITBY FORMATION
1 Black shale.

* *The* SEMINARY TILL *appears only in the sections.*

SYMBOLS

County boundary.

Township boundary.

Topographic contours.

Geological boundary, approximate.

Sand or gravel pit.

Lake Iroquois shoreline.

For other conventional signs refer to 1:25,000 National Topographic Map Series.

ONTARIO
DEPARTMENT OF MINES
HON. G. C. WARDROPE, *Minister of Mines*
D. P. Douglass, *Deputy Minister* M. E. Hurst, *Director, Geological Branch*

Map 2077

Pleistocene Geology of the SCARBOROUGH AREA

East Sheet

SOUTHERN ONTARIO

Scale 1:31,680 or 1 Inch to ½ Mile

Chains 80 60 40 20 0 1 2 Miles
Metres 1000 0 1 2 3 Kilometres
Feet 1000 0 5,000 10,000 Feet

SOURCES OF INFORMATION

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